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ORIGINAL ARTICLES.

I. — On the Bone-beds of Pikermi, Attica, and on similar Deposits in Northern Eubœa.

By A. Smith Woodward, LL.D., F.R.S.

AT the suggestion of the British Minister at Athens, Sir Edwin H. Egerton, K.C.B., the Trustees of the British Museum recently undertook a series of excavations in the well-known bone-beds of Pikermi, in Attica, and I was honoured by being entrusted with the supervision of the work. The owner of the estate, Mr. Alexander Skousés, former Minister of War, most cordially assented, and gave every possible facility for the undertaking; while Sir Edwin Egerton's unflagging interest and zeal combined to ensure the greatest success. My wife and I went into residence at the farm of Pikermi early in April, and we continued to occupy the simple but comfortable room which Mr. Skousés had kindly placed at our disposal, until the cessation of digging in the middle of July. During much of the time we were accompanied by Dr. Theodore Skouphos, Conservator of the Geological Museum in the University of Athens, which claims some share of the results of all such excavations made in Greece. We have to thank him for much help in dealing with the workmen, who spoke only a language with which I was at first unfamiliar.

The bones are occasionally exposed by the small stream in the ravine of Pikermi, and they seem to have been first observed by the English archæologist George Finlay, who presented some to the Athens Museum in 1835. Three years later a Bavarian soldier took a few specimens to Munich, where Pikermi and its fossils were first brought to the notice of the scientific world by Professor Andreas Wagner. Within the next decade, more bones were sent to Munich by Lindermayer and described by Wagner; while during the Winter of 1852–53 the young Bavarian naturalist Roth made the great collection which was described by himself and Wagner in 1854, and still constitutes one of the chief treasures of the Munich Old Academy. About the same time Choeretis presented a few specimens to the Paris Museum; while the late Professor

Mitzopoulos, uncle of the present distinguished Rector of the University of Athens, made a valuable and extensive collection for the Athens Museum, which seems to have remained unnoticed until 1883, when the late Professor Dames, of Berlin, studied it, and wrote a brief account of some unique specimens contained in it.[1] By far the most important excavations hitherto made at Pikermi, however, are those which were undertaken by Professor Albert Gaudry, under the auspices of the Paris Academy of Sciences, between 1855 and 1860. These researches made known nearly all the essential facts concerning the extinct mammalian fauna entombed in the Pikermi formation, and led to several brilliant generalizations first published in Professor Gaudry's well-known work on the geology and fossils of Attica in 1862.[2] During the last 40 years only insignificant diggings have been attempted, among them being those of the late Professors Neumayr, of Vienna, and Dames, of Berlin.

Owing to the permanent mark left by former excavations it was easy to choose sites for the new explorations of the British Museum. Three pits dug in continuation of former workings soon yielded bones, and eventually furnished a very extensive collection. Two trial pits at other points and in slightly different horizons produced nothing except two decayed bone-fragments. Water still occurs even in dry weather a little beneath the bed of the stream; but the difficulties from this source are now much less than formerly, owing to Mr. Skousés' system of irrigation, by which the flowing stream of the ravine is usually diverted at a point high up in its course.

The Pikermi formation has already been well described by Professor Gaudry. It consists chiefly of red marl, varied with lenticular masses of rounded pebbles and occasional yellowish sandy layers. Some of the pebble-beds are cemented into hard conglomerate. The materials are such as might have been derived from the mountain mass of Pentelicon which forms the neighbouring high ground, the marl itself being apparently the detritus of marble or other calcareous rock. The formation is of great extent in Attica, and has only attracted special notice at Pikermi because a stream happens to have cut a deep ravine through it and exposed fine sections of the beds.

As already observed by Professor Gaudry, the bones at Pikermi occur on two definite horizons, those in the lower bed being less fragile and better preserved than those in the upper bed.[3] In two of our new pits where the upper horizon is well exposed, it is subdivided into two distinct layers by a nearly barren deposit of marl from 30 to 45 cm. in thickness. The rotten nature of the bones is partly due to their having once been close to or at the surface,

[1] W. Dames, "Hirsche und Mäuse von Pikermi in Attika": Zeitschr. deutsch. geol. Ges., 1883, p. 92, pl. v.

[2] A. Gaudry: "Animaux Fossiles et Géologie de l'Attique," Paris, 1862. This work contains references to previous literature.

[3] A. Gaudry, "Résultats des Recherches faites à Pikermi (Attique), sous les Auspices de l'Académie": Comptes Rendus, vol. xlii (1856), p. 291.

and eroded by the present stream before being covered with the three or four metres of superficial gravel which now preserves them. The bones are also broken by the penetrating rootlets of trees. The lower horizon is at a depth varying from one to two metres below the upper horizon, and thus secure from destruction by surface agencies. Like each of the two upper bone-beds, it is rarely more than 30 cm. in thickness; while the marl above and below it is almost destitute of bones, rarely yielding more than rotten fragments, but quite prolific in scattered land and fresh-water shells. The deepest excavations beneath the lower bone-bed descended for about three and a half metres, and furnished the bone-fragments and shells throughout. No traces of vegetable matter were observed in any layer.

So far as can be judged at present from the new excavations, the three bone-beds of Pikermi are all of the same nature and contain the same mammalian remains. The bones are massed together in inextricable confusion, and are often mixed with a few pebbles. Large and small bones, whole specimens and splintered fragments, all occur together; but the small bones are usually most numerous at the bottom of the layer. Several specimens of approximately the same shape and size are often met with in groups, as if they had been sorted by water in motion. On one occasion, for example, the scattered remains of many gazelles were found together; in another spot there were several skulls of *Tragoceras* in one mass; in other cases nearly all the bones belonged to limbs of *Hipparion*; while one area was specially characterized by pieces of vertebral columns of Ruminants and *Hipparion*. The elongated bones and elongated groups, however, were never observed to trend in one definite direction, but were always disposed quite irregularly; thus indicating that in the region where the bones eventually accumulated, the water by which they had been transported either became still or moved only in gentle eddies.

Very few nearly complete skeletons occur, and even when chains of vertebræ are preserved most of the ribs are lacking. The only approximately complete skeletons observed during the recent excavations were those of some Carnivora (*Ictitherium*, *Metarctos*, and *Machærodus*). It is, however, obvious that many of the bones were still held together by ligaments at the time when they were buried; for numerous complete feet and nearly complete limbs are found with all the bones in their natural position. It is also to be noted that in most cases these limbs are sharply bent so that the two or three segments are almost parallel, as if they had retained the contraction assumed at death. Some decomposition of the soft parts had already taken place even in these instances; for a few of the phalanges of the hipparions and ruminants are often wanting when the other bones of the limb are still in their natural association, while the phalanges of the rhinoceros feet seem to be always lost, though the three associated metapodials are quite common. Similarly, the loosely articulated mandible of the Ungulata is nearly always removed from the skull; it is only commonly preserved in place in the Carnivora and Quadrumana.

The majority of the bones are quite isolated, and most of the skulls of the antelopes are so much broken that only the frontlets with horn-cores remain. A large proportion of the limb-bones are also sharply fractured, some having completely lost both extremities; and small pointed splinters of bone, apparently most of *Rhinoceros*, are often very numerous. Some of the breaking must have taken place before the soft parts had entirely decayed, as is shown by certain feet of *Rhinoceros* and many limbs of *Hipparion* and antelopes. In a few cases I found the three associated metapodials of *Rhinoceros* with the distal ends as sharply removed as if they had been cut off with one blow of a hatchet. In several instances I carefully extracted the nearly complete hind limbs of *Hipparion* from the soft marl, and in all except one I found that the tibia ended abruptly in a sharp, oblique fracture at its middle, with no trace of the proximal end of this bone or of the femur. Moreover, nearly all the isolated tibias of *Hipparion* were similarly fractured; while among about fifty examples of humerus of the same animal only three complete specimens were found, all the others being sharply broken at the weakest point of the shaft. It is therefore evident that the limbs were often torn from the trunk by a sharp break at the weakest point before the decomposition of the soft parts had proceeded far enough to destroy the ligaments.

The new researches make scarcely any additions to the known fauna of the Pikermi bone-beds, and confirm Professor Gaudry's statement that the smaller rodents, insectivores, and bats are absent. The only striking discovery consists in fragmentary evidence of a gigantic tortoise, at least as large as the largest hitherto found in Europe. Many specimens, however, afford important new information concerning the species already described. Notable among these are a few portions of skull and a mandible of *Pliohyrax*, a skull of *Samotherium*, a skull of *Hystrix primigenia*, and the greater part of a skeleton of *Metarctos*. Remains of *Hipparion* are the most abundant fossils, and the new series of specimens illustrates variations and growth-stages more satisfactorily than any collection hitherto made. Isolated bones and skulls of *Rhinoceros* are also common, and antelope remains occur everywhere in great profusion. Limb-bones of Giraffidæ are found abundantly in the lower bone-bed. *Mastodon* is rarer, but two small skulls were obtained from the new excavations, and several very large limb-bones were found. Among Carnivora, *Ictitherium* is the commonest form; but remains of *Hyæna* are not infrequent, and evidence of four individuals of *Machærodus* was discovered during the present diggings. Coprolites of some bone-feeding Carnivore, probably *Hyæna*, also occur. Skulls and other portions of *Mesopithecus* are frequently met with. The shells of the small *Testudo marmorum* are sometimes complete, but always lack the skull and other bones of the skeleton. The Chelonian shells themselves are, indeed, more frequently broken and disintegrated, and a large proportion of the bone-fragments discovered between and below the bone-beds are recognizable as pieces of them. It is noteworthy that a good specimen of *Testudo*

marmorum was found in the marl between the upper and lower bone-beds in one pit; and a small undetermined snake was discovered in a similar position in another pit.

While the excavation of these fossils was in progress at Pikermi, Mr. Frank Noel, of Achmet Aga in Northern Eubœa, accompanied Sir Edwin Egerton on one of his visits. He recognized that the Pikermi marls were similar to some containing fossil bones on his own estate. He also perceived the identity of the remains of *Hipparion* at Pikermi, with the commonest fossil bones with which he was familiar at Achmet Aga. Many years ago he had sent some of these bones to the Athens Museum; but they seemed to have been lost and had never received any attention from the Greek naturalists. He therefore invited the British Museum to examine the discovery on his estate, and decide whether or not the extinct Pikermi fauna was there represented.

A brief visit to the locality where the bones occur, near Achmet Aga, sufficed to confirm Mr. Noel's impressions. The interesting spot is in a deep ravine on the steep slope just below the village of Drazi, at an elevation of nearly 200 metres above the sea-level.[1] The torrent has cut through a thick deposit of red, indurated marl, much like that of Pikermi; and bones are noticeable in the section at many points. Three days' digging at one place revealed two bone-beds separated by a thin layer of marl. The bones seem to be as abundant and varied as those at Pikermi, and they exhibit exactly the same features. *Hipparion* is again the commonest fossil, and mingled with the complete bones are splintered fragments. Land and fresh-water shells also occur in great abundance, especially a species of *Planorbis*.

Nearly all the bones discovered during this brief visit were too rotten for preservation; but the weathered face of the section alone was explored, and the fossils would doubtless be found in good condition further inwards. Among them could be recognized, besides the innumerable remains of *Hipparion*, parts of a skull and tibia of *Rhinoceros*, a frontlet of *Gazella brevicornis*, jaws of a small ruminant, a large ruminant metapodial (probably *Samotherium*), part of a skull and mandible of *Ictitherium*, and some small carnivore vertebræ. There was also part of the skull of a small species of *Orycteropus*, which I was able to preserve and bring for comparison with the skull of the same genus from Samos now in the British Museum.

From these observations it is evident that the Pikermi bone-beds are not merely a local accident, but are due to some widespread phenomenon. The two localities described are about 60 miles apart, and seem to be situated in two distinct Tertiary basins separated by a barrier of Cretaceous limestones and earlier rocks. Whatever the catastrophe may have been by which the animals were suddenly destroyed, it clearly happened in both places at least twice, if not three times, within a comparatively short period. The

[1] For a brief account of the district see F. Teller, "Der Geologische Bau der Insel Euboea": Denk. k. Akad. Wiss., math.-naturw. Cl., vol. xl (1880), pp. 156–160.

powerful force which broke up and transported the bodies before they had completely decomposed, was probably the same in each case; while the final resting-place of the bones both at Pikermi and Drazi must have been beneath comparatively tranquil water, where they could be quickly buried in mud. The absence of all trace of vegetable matter is curious; but the most plausible explanation of the broken limbs and torn portions of trunks seems to be, that the bodies were hurried by torrential floods through thickets or tree-obstructed watercourses, before they reached the lakes in which they finally rested. Accompanying stones in rapid motion may account for some of the bone-fragments.

II.—On some Crustacea collected by Miss Caroline Birley and Miss L. Copland from the Upper Cretaceous of Faxe, Denmark.

By Henry Woodward, LL.D., F.R.S., V.P.Z.S., F.G.S.

(PLATE XII.)

IT is, I regret to say, some long time since my friend Miss Caroline Birley placed in my hands the series of Crustacea which she had, with the assistance of Miss L. Copland, collected from the Upper Cretaceous of Faxe, Denmark.

As in the interval, K. O. Segerberg has figured and described many of these species in Sweden,[1] I propose to give a translation of his descriptions of such species as I find to be identical with those in Miss Birley's collection, it being obviously needless to describe them over again.

Miss Birley has favoured me with the following note on the Upper Cretaceous quarry of Faxe, Denmark:—

"Dr. Henry Woodward, having kindly undertaken to report on the Crustacea obtained by Miss L. Copland and myself on two visits to the Upper Cretaceous (Danian) beds of Faxe, Denmark, has asked for a note on the locality, known to English geologists far better by repute than from actual experience.

"Situated in the south-east of the island of Zealand or Seeland, where, though the land is rich and fertile, the scenery is merely pretty with beech-woods and grass meadows, Faxe offers little to the ordinary tourist, and when we were there only three trains daily connected it with Copenhagen, the journey occupying from $2\frac{3}{4}$ hours to $6\frac{3}{4}$. There were then three stations with the name of Faxe—Faxe, Faxe Strand (now Stubberup), and Faxe Laderplads—and Faxe being an inland hill, and not an island, as the usual misspelling of the name indicates, we dismounted at the first, and saw opposite, a little hostel, the only visible building. Here a genial couple made us so comfortable, in homely Danish fashion, that I can only add the fact that there *is* a more orthodox-looking inn in Faxe village, a mile or so away. From either end, the quarry is reached in a few minutes walk. Danish is the only language

[1] Geol. Fören. Stockholm, 1900.

spoken, but a little of it goes a long way with the intelligent and friendly people.

"Approaching the quarry from the north, the low green hill rises before one like a high railway embankment, and on entering by an upland path, or through the cutting for the transport railway, one finds that a large portion of the hill has already been excavated, in a shape between the letter L and a high boot narrowed at the top. The greatest length, about half a mile, is from east to west, and the cliffs or walls which practically surround the quarry, rise to heights varying from 60 to 80 feet. The character of the rock ranges from a compact creamy or pale yellow limestone, used for building purposes, to ordinary white chalk, coral occurring in large masses in this ancient coral-reef. Unfortunately I have no notes of the sequence of the beds, and probably the zones have not yet been worked out. The fossils of most frequent occurrence are the coral *Cladocora dichotoma*, carapaces of *Dromiopsis rugosa*, and casts of *Nautilus* (*Hercoglossa*) *danicus* and *Trochus lævis*. *Baculites Faujusii*, always mentioned as characteristic of this deposit, must be more frequent or better preserved in the 'Faxelaget' of Stevns Klint and the island of Moen. If we met with it at all in Faxe, it was rarely. The prevalence of Gasteropods is a marked feature, and among the more striking of our acquisitions are a *Voluta* allied to *V. Lamberti* and a large *Pleurotomaria*. The shells almost always occur as casts.

"Fallen boulders of pink granite may occasionally be noticed in the quarry, and one at least was then *in sitû* near its northern entrance."—*C. Birley.*

The youngest member of the Cretaceous formation of Scandinavia is the Danian of Faxe (spelt incorrectly 'Faxoe' by Darwin,[1] Prestwich, and others). This stage is wanting in England, but has its equivalent in the Danian and Maestrichtian systems of Belgium and Holland, and the Calcaire Pisolitique and Calcaire à *Baculites* of France. According to Prestwich it is from 45 to 50 feet thick, and consists almost entirely of fragments of corals and Polyzoans (Bryozoa), with *Nautilus Danicus*, *Belemnitella mucronata*, *Baculites Faujasii*, *Cypræa bullaria*, etc.[2]

K. O. Segerberg[3] writes:—"The lower layer of the Faxe Chalk is composed of compact or hard tubular limestone, largely composed of corals, hence called coral-chalk. Here and there one finds a lighter and less compact bed almost wholly composed of Bryozoa. Both the coral-chalk and the Bryozoa-chalk are very rich in fossils, contrasting in this respect with the Saltholms Chalk, which is a more homogeneous, and in its upper layer looser, chalk-rock, formed under other conditions than the Faxe Chalk, which is the remains of an old coral-reef."

[1] Charles Darwin described some remains of Cirripedia (*Pollicipes striatus*, *P. elegans*) from Faxe (incorrectly spelt Faxoe), Denmark: Pal. Soc., 1851, pp. 70, 76. It is, I regret, spelt 'Faxoe' on the Plate accompanying this paper.—H. W.

[2] Prestwich's "Geology," 1888, vol. ii, pp. 7 and 302.

[3] "De Anomura och Brachyura Dekapoderna inom Skandinaviens Yngre Krita": Geol. Fören. I Stockholm Förhandl., 1900, Bd. xxii, H. 5, p. 1.

In Miss Birley's collection there is (in addition to various portions) an entire carapace of *Galathea* which agrees best with *Galathea munidoides*, K. O. Segerberg (Pl. XII, Fig. 8). I have also referred to this species the small detached chela (Pl. XII, Fig. 9). I mentioned the carapace of *Galathea* in my second year's Anniversary Address to the Geological Society of London.[1]

The subjoined descriptions have been most obligingly translated for me by Mr. C. A. Ryman, from Mr. K. O. Segerberg's paper "De Anomura och Brachyura Dekapoderna inom Skandinaviens Yngre Krita."[2]

MACROURA—ANOMALA.

Fam. GALATHEIDÆ, Dana.

1888. *Galatheidæ*, Henderson: Anomura, p. 116.
1894. *Galathéidés*, Milne-Edwards et Bouvier: Galathéidés, p. 191.
1897. *Galathéidés*, Milne-Edwards et Bouvier: Dredging by "Blake," xxxv.

One often finds both in the coral-chalk and the Bryozoan-chalk fragments or casts of carapaces with those peculiar cross striæ which are characteristic of the different genera of this family. Steenstrup had already noticed these, and created the species *Galathea strigifera*. Lundgren was the first who attempted to describe and illustrate such fragments. Along with these Crustacean remains are found small claws, which from their size, flat form, and finely serrated edges agree with the type peculiar to this family. Von Fischer-Benzon was the first who noticed and identified these claws. This is all that is mentioned about the fossil representatives of this group in the earlier literature. In 1897 Moericke has contributed some valuable information on the genus *Galathea* in "Die Crustaceen der Sternberger Schichten." In this are recorded no less than four species of this family from the youngest Jurassic formation, all, however, of a type alien to the Danian. We may also refer to Pelseneer (Decapod. du Maestricht, p. 166) and Ristori (Crost. Pliocen, p. 36).

When studying the collections from Faxe in the Mineralogical Museum at Copenhagen, K. O. Segerberg says, "I was fortunate enough to find amongst the matrix of Bryozoan-chalk several well-preserved specimens with the rostrum in more or less good condition. By means of this material I have also been able to give a complete description of *Galathea strigifera*, Steenstrup." [This species is not represented in Miss Birley's collection.]

GALATHEA STRIGIFERA, Steenstrup, sp.

? *Galathea strigifera*, Steenstrup, sp.
1866. ,, ,, Von Fischer-Benzon: Das Alter d. Faxekalkes, p. 28, pl. v, figs. 4–6.
1867. ,, ,, Lundgren: Faxekalken, p. 11.
1900. ,, ,, Segerberg: De Anomura och Brachyura Dekapoderna in. Skandinav. Yngre Krita, pl. i, figs. 1, 2 ?

[1] Quart. Journ. Geol. Soc., February 21, 1896, vol. lii, p. cviii.
[2] Geol. Fören. I Stockholm Förhandl., 1900, Bd. xxii, H. 5, pp. 42, 3 plates.

Length (of the specimen in the diagram), 6 mm.; breadth, 4 mm. The greatest breadth is just behind the middle.

Rostrum triangular; its superior surface is concave, with three or four sharp spines on each side, which are directed forwards and diminish in size from before backwards. Anterior margin narrow and a little elevated near the point. Lateral margin curved somewhat outwards behind the centre, and provided anteriorly with small pointed teeth which are directed forwards, and of which the anterior one is a little larger than the rest. The occipital sulcus and its branches are shallow. The surface of the carapace is characterized by more or less well-marked cross-lines, of which the two anterior ones are drawn out into a short point directed forwards and the posterior ones run from side to side. Between these, as well as on the rostrum, the surface is more or less granulated. Cardiac region more or less prominent, and in some specimens provided with a sulcus in front.

This species varies in this respect, that the teeth on the rostrum are sometimes fairly large, and sometimes are very minute, needle-shaped, and nearly invisible.

Regarding the carapace, *G. strigifera* shows a great similarity with *G. strigosa* (found in the North Sea), and is perhaps a precursor of this form.

This species occurs abundantly both at Annetorp and Faxe.

The following species of *Galathea* is in Miss Birley's collection :—

GALATHEA MUNIDOIDES, K. O. Segerberg. (Pl. XII, Figs. 8, 9.)

(Figures enlarged 4 times nat. size.)

K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., 1900, Bd. xxii, H. 5, pl. i, fig. 5.

This species is represented by two rather incomplete specimens, preserved as casts, both from Faxe. The length of the specimen figured in Pl. XII, Fig. 8 is 7 mm., the breadth about 4·5 mm.

The rostrum is narrow and triangular, its superior surface smooth and slightly concave, the borders are smooth and provided on each side of the base with a tooth directed forwards. The anterior margin of the rostrum is fairly well raised; the lateral margin is curved in front of and behind the antero-lateral branch of the occipital furrow, but is otherwise straight with indistinct, blunt teeth. The occipital furrow and its branches are well marked. The cross-lines are elevated, and run posteriorly from side to side in a way peculiar to this species. The cardiac region is not prominent. The gastric region anteriorly is sharply distinguished from the frontal region, which is situated on a lower level; in the centre it is provided with a ridge which is continued on to the rostrum. On both sides of this ridge, a little behind the front border, are four small prominences arranged in a semicircle and diminishing in size outwards.

This species exhibits, particularly in the form of its rostrum, an interesting transitional form between the genera *Galathea* and *Munida*. The triangular form of the rostrum and its superior

surface being slightly concave show its relationship to *Galathea*, and on the other hand the non-serrated ridges and the two teeth situated at the base on either side are found in the *Munida*-type, which is represented by *Munida primæva*, n.sp.

Several existing species are known which, as regards the formation of the rostrum, are transitional forms between *Galathea* and *Munida*, which, however, have been arranged as separate genera. Such are the *Pleuroncodes* of Stimpson and the *Grimothea* of Dana. In both these genera one finds a small, triangular, non-serrated rostrum, provided with teeth on each side at the base.

Pleuroncodes[1] differs, however, both from *Galathea* and *Munida*, amongst other peculiarities, in its breadth. Recent authors[2] consider *Grimothea* to belong to the genus *Munida*. Of the living species of *Galathea*, *G. pusilla*, Henderson,[3] is nearest to *G. munidoides*; but its rostrum is provided with a small tooth on each side in front.

Munida primæva, K. O. Segerberg.

K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., 1900, Bd. xxii, H. 5, p. 8, pl. i, fig. 6.

Only one specimen of this species has been found from Faxe, preserved as a cast; still, the shell can be partially seen at the sides, but the rostrum and lateral teeth are broken. The greatest breadth at the centre of the carapace is 5 mm.; the length from the base of the rostrum to the posterior margin is 6 mm. The rostrum is narrow, spear-shaped, provided with a small tubercle on its superior surface, from which runs a fine ridge along the middle line as far as the occipital furrow; at the base of the rostrum there is on each side a pointed tooth.[4] The anterior margin is well defined on either side of the rostrum, and still more along the lateral margin. The lateral margins are slightly but evenly curved, and provided with small pointed teeth directed forwards; of these the anterior one is much larger than the rest, and forms the demarcation of the angle between the anterior margin and the lateral margin. The occipital furrow and its branches are deep and distinct. The regions on the border are well defined, and are thinly but sharply granulated. Besides this the superior surface shows several ridges, anteriorly alternately longer and shorter, and here and there are small tubercles. The cardiac region is short and broad, with a narrow, straight sulcus in front and behind; it is crossed by three lines, the two anterior ones converging towards the sides. The middle part in front of the occipital furrow forms an oval area pointed towards the sides. On the gastric region, near the middle line, in front, are two tubercles (on the carapace itself there have probably been teeth corresponding to these); outside and below these are smaller, more or less pointed ones (on both the cast and

[1] Ortmann: Arthropoda, p. 1150.
[2] Milne Edwards: "Crustacés du Cap Horn," p. 32.
[3] Henderson: Anomura, p. 121, pl. xii, fig. 1.
[4] After the original specimen had been drawn it was being still further developed, and in this operation the rostrum was unhappily destroyed.—K. O. S.

the test). A similar form of rostrum, with lateral teeth placed closely together at the base, is also found in recent species of *Munida*, e.g. *M. forceps*, Milne-Edw.[1]

Lundgren says, in the description of *Galathea strigifera*, "that the lateral parts, defined by the above-mentioned curved lines, are granulated, and that the middle one is most prominent." This shows probably that Lundgren, amongst his specimens of *Galathea*, had also the above described species of *Munida*.

BRACHYURA—ANOMALA.

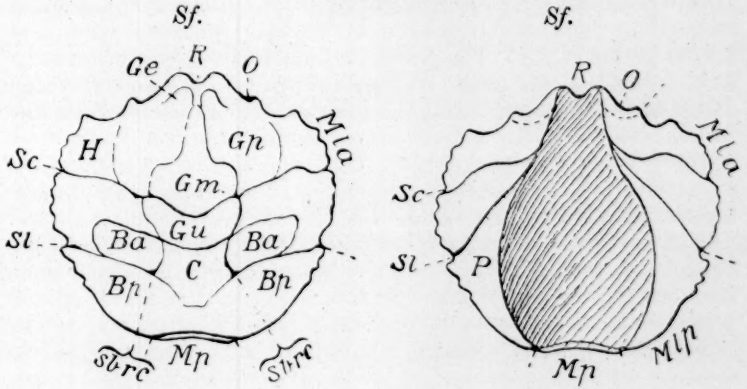
Fam. DROMIDÆ, Stebbing.

Gen. Dromiopsis, Reuss.

1859. *Dromiopsis*, Reuss: Fossil. Krabben, p. 18.
1866. *Dromia*, Von Fischer-Benzon: Alter d. Faxekalkes, p. 23.
1900. *Dromiopsis*, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, p. 9.

The carapace is circular or pentagonal, a little broader than long, much arched in front, flatter behind. The rostrum is triangular and bent downwards, with a shallow sulcus or furrow along the

Diagram of Regions and Divisions of Carapace in a Brachyuran Decapod Crustacean.



Upper Surface. Under Surface.

Sf.	frontal furrow.	*Ge.*	epigastric lobe.
R.	rostrum.	*Gm.*	mesogastric lobe.
O.	orbits.	*Gp.*	protogastric lobe.
Mla.	antero-lateral margin.	*Gu.*	urogastric lobe.
Mlp.	postero-lateral margin.	*H.*	hepatic region.
Mp.	posterior margin.	*C.*	cardiac region.
Sc.	cervical or occipital furrow.	*Ba.*	antero-branchial lobe.
Sl.	lateral furrow.	*Bp.*	postero-branchial lobe.
Sbrc.	branchio-cardiac furrow.	*P.*	pterygostomial region.

middle line; its borders are even and raised; the orbits are rather small, somewhat close together, and are open internally towards the rostrum, from which they are only separated by a small ridge of the posterior wall. The inferior orbital border is provided with

[1] Milne-Edwards et Bouvier: Dredging of SS. "Blake," p. 28, pl. ii, fig. 8.

two teeth, of which the external one is the larger. The antero-lateral margins (*Mla.*) are long, much curved, and provided with teeth varying in number and often confluent. The postero-lateral margins (*Mpl.*) are shorter, nearly straight, and curving inwards; they are provided in front with one or two more or less indistinctly marked teeth. The posterior margin (*Mp.*) is generally short and somewhat incurved. The superior surface of the carapace is divided transversely into three areas by two sulci (or furrows), the anterior of which is named the *cervical* furrow (*Sc.*) (called also the occipital furrow), and the posterior the *branchio-cardiac* furrow (*Sbrc.*) or lateral furrow (*Sl.*). The branchio-cardiac furrow is more or less bent backwards, and often takes a sharp curve forwards, and, having received a smaller sulcus from the part in front, it continues on to the arched margin of the carapace forming the lateral furrow (*Sl.*). This sulcus, which marks the middle of the superior surface of the carapace, is indicated only by a notch on the lateral margin over which it passes, and is continued forwards upon the inferior orbital border of the pterygostomial region (*P.*).

Of the different regions observed on the carapace the epigastric (*Ge.*) and the mesogastric lobes (*Gm.*) appear in front of the occipital furrow (also called the cervical furrow) (*Sc.*). The two epigastric lobes (*Ge.*) are nearly always well marked, and are separated by the frontal furrow (*Sf.*). The mesogastric lobe (*Gm.*) is prolonged in front into a narrow point, and divided behind into two parts by a sulcus running lengthwise, and in decorticated specimens, from which the shell has been dissolved away, this furrow is always well defined by two well-marked raised surfaces (these marks being due to the insertion of muscles on the interior of the carapace). Behind the occipital furrow (also called the *cervical* furrow), in the front part of the centre of the carapace, is the broad urogastric lobe (*Gu.*) (not always well defined). This is separated from the next region by a narrow, plane or concave surface. The cardiac region (*C.*) is pentagonal, with the pointed portion directed backwards, and on decorticated specimens nearly always marked by three tubercles, forming a triangle; on each side, behind the occipital furrow, are the two large branchial regions (*Ba.* and *Bp.*). The anterior branchial regions (*Ba.*), situated in front of the lateral sulcus or furrow, possess on decorticated specimens, in the centre, a pointed elevation. The posterior branchial regions (*Bp.*) are of a more or less marked rhomboidal form. Two tubercles can always be seen in decorticated specimens in the middle of the occipital furrow. The pterygostomial region (*P.*) is very narrow. On this, behind the lower border of the orbit, is a transverse furrow or sulcus, which is often sharply marked, particularly on the inner part, where the region behind is more or less pointed.

The superior surface is granulated or smooth, the curved part nearly always smooth. In the collections both from Annetorp and Faxe there are isolated well-preserved claws, which in their short, stout form and the direction of the index and pollex resemble the

Dromia-type, but which are devoid of the denticulations peculiar to *Dromia*. These claws belong, no doubt, to representatives of the genus *Dromiopsis*, which is so stated in one case (cf. *D. lævior*); among others of the figured species one is granulated in the same way as the shell of *D. rugosa*, and belongs probably to that species.

Of the genus *Dromiopsis* four species are already described, all belonging to the newer Chalk formation, and all except *D. elegans* known only from the Faxe Chalk. *Dromiopsis gibbosus*, Schlüt.,[1] from the *Belemnites mucronatus* Chalk formation of Westphalia, does not belong to this family, but ought probably to be referred to the family *Homolopsis* of Bell.

Dromiopsis resembles in many respects *Dromia*, and Von Fischer-Benzon considered these two to be identical. Lundgren is also of the same opinion. This is easily explained, as the genus *Dromia* formerly comprised many more types than are now included with our present knowledge of the genus. (Ortmann, "Arthropoda," p. 114.)

"After examining recent specimens in the Zoological Museum of Copenhagen I have been able to show distinct generic differences between *Dromia* and the genus *Dromiopsis* as proposed by Reuss. *Dromia* differs very distinctly from *Dromiopsis* by its three-toothed rostrum, and also by its long, nearly straight posterior border, much larger pterygostomial region, and its very peculiarly serrated claws. The genus *Dromiopsis* ought thus to be maintained and to be considered as a precursor of *Dromia*. This last-mentioned genus appears first in the Tertiary period, from which Bittner[2] has described several types all with the rostrum three-toothed. But as regards the pterygostomian region these Tertiary species of *Dromia* resemble *Dromiopsis* (cf. Bittner, 'Brachyuren v. Vicenza, Neue Beiträge,' p. 307)."

"The genus *Dromilites* of Milne-Edwards,[3] belonging to the Tertiary formation, with which *Dromiopsis* has also been considered as identical, ought necessarily to be revised. The species belonging to this genus differ more or less from *Dromiopsis* by the denticulations on the lateral borders, by more distinct regions, and by the shape of the branchial regions. Zittel's[4] diagnosis of the relationship both of *Dromiopsis* and *Dromia* is now inapplicable."

DROMIOPSIS RUGOSA, Schlotheim, sp. (Pl. XII, Figs. 3*a*, *b*, and 4*a*–*c*.)

1820. *Brachyurites rugosus*, Schlotheim: Petrefactenkunde, p. 36, pl. i, fig. 2.
1851. *Brachyurites rugosus*, Quenstedt: Petrefactenkunde, p. 401, pl. xxxi, fig. 11.
1859. *Dromiopsis rugosa*, Reuss: Fossil. Krabben, p. 10, pl. iii, figs. 2, 3; pl. v, fig. 6.
1866. *Dromia rugosa*, Von Fischer-Benzon: Alter d. Faxekalkes, p. 24, pl. iii, figs. 1–3.
1867. *Dromia rugosa*, Lundgren: Faxekalken, p. 10.
1900. *Dromiopsis rugosa*, Schlotheim, sp.: K. O. Segerberg, Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5.

[1] Schlüter: Krebse d. nördl. Deutschl., p. 610.
[2] Bittner: Brachyuren v. Vicenza, Neue Beiträge, p. 306, pl. i, fig. 5; Decapoden d. pannon. Tertiär, pp. 21, 25, pl. ii, figs. 5, 6.
[3] Bell: "Crust of London Clay," p. 27, pl. v, figs. 1–9; pl. vi.
[4] Zittel: Palaeont., ii, p. 703.

The carapace in outline is of a rounded pentagonal form, with its greatest breadth a little anterior to the middle; of nearly the same length as breadth (1 : 1·1); very convex, particularly anteriorly, the posterior part being flatter and often having a depression in the centre. In size it varies from a breadth of a few millimetres up to 40 mm.; generally it is from 20 to 25 mm. The rostrum (*R.*) is strongly depressed; the orbits (*O.*) are deep; their inferior border forms a blunt process with two teeth. The antero-lateral margin commences with a sharp tooth somewhat below the inferior orbital border; in other respects the lateral margins agree generically. The posterior margin is sometimes short and much curved, in others long and less curved; this is probably due to difference in sex. The occipital and lateral sulci or furrows are deep and sharply defined; somewhat broader on the superior surface than on the curved part. On the inner half of the anterior branchial regions there runs parallel to these a much shallower middle sulcus, which forms a right angle externally and ends in the lateral furrow (on some specimens there are traces of such a curved furrow going off anteriorly towards the occipital or cervical furrow). The epigastric lobes form two pointed eminences. The mesogastric lobe is well defined, and elevated posteriorly. The protogastric lobes are not so well defined in this type. The urogastric lobe is characterized by irregular eminences. Between this and the cardiac region there is a saddle-like depression, the anterior part of which, towards the sides, blends with the above described middle sulcus. The centre of the cardiac region is more or less elevated, and anteriorly it is externally defined by the branchio-cardiac furrow, which on some specimens is shallower, and runs forwards and outwards and unites with the occipital or cervical furrow. The superior surface is ornamented with granules varying in size, which become less posteriorly and are not so well defined (except on the nearly smooth sulci). The inferior surface has granules only on its anterior part.

The above described details are readily seen on all decorticated specimens and are present on even very small specimens; on larger and older examples they have often been more or less obliterated. Specimens with the surface of the shell well preserved are not rare; the granules in these are very distinct, and do not diminish in size posteriorly, and are seen also on the arched part of the carapace.

Dromiopsis rugosa is not only without doubt one of the most common decapods of the Faxe Chalk, but also generally one of its most common fossils.

Of this little varying type Segerberg records having found the following different forms (see Pl. XII, Figs. 4*a*–*c*, × 2 nat. size).

(*a*) *Forma inflata*, small, more strongly and more uniformly arched, with the regions less markedly distinguished; several specimens. (Segerberg, op. cit., 1900, pl. i, fig. 10.)

(*β*) *Forma angusta*, small, strongly arched from side to side; somewhat longer than broad, quickly tapering behind the occipital furrow towards the very short posterior margin. The posterior part of the mesogastric lobe separated by a well-marked sulcus from

the protogastric lobes, which are pointed downwards and inwards. This is probably a variety of *D. rugosa.* (Segerberg, op. cit., 1900, pl. i, fig. 2.)

(γ) *Forma nodosa*, large, with its middle lobes much accentuated and elevated (particularly the posterior part of the mesogastric lobe and the inner half of the antero-branchial regions); the protogastric lobes on the antero-lateral border are also elevated. (K. O. Segerberg, op. cit., 1900, pl. i, fig. 12.)

DROMIOPSIS MINOR, Von Fischer-Benzon, sp.

1866. *Dromia minor*, Von Fischer-Benzon: Alter d. Faxekalkes, p. 25, pl. iii, figs. 4–6.
1867. ,, ,, Lundgren: Faxekalken, p. 11.
1900. ,, ,, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, pl. i, fig. 14.

Circumference nearly round; the breadth is to the length as 16 : 15; the arching is fairly uniform all over, but a little flatter posteriorly. The size varies from 15 to 27 mm. in breadth. The rostrum is broad, triangular, and not so much depressed as in *D. rugosa.* The lateral margins are evenly curved; the antero-lateral margin begins close to and on the same level as the inferior orbital border, and has 5–6 short conical teeth, generally well separated. The postero-lateral margin anteriorly is marked by a tooth. The posterior margin is longer and less curved than in *D. rugosa.* The occipital furrow is fairly deep, forming an angular bend on the pterygostomial region. Lateral furrow shallow. The different regions much less prominent than in the preceding species. The cardiac region is defined anteriorly by a fine straight line.

The superior surface sparsely provided with small, mostly pointed tubercles, forming a row on each side of the lateral furrow. The cardiac region and the postero-branchial lobes are provided with much fewer tubercles, or they are absent altogether. In other respects it corresponds with *D. rugosa.*

This species, described by Von Fischer-Benzon, was by him supposed to be identical with *D. minuta* of Reuss.[1] The description by Reuss, however, is very vague, differing little from *D. elegans* as this species is described and illustrated by Reuss[2] himself, and it is therefore probably only a form of this very variable species from which he has formed his description. *D. minuta*, Reuss, ought thus to be abolished.

D. minor appears rarely both at Annetorp and at Faxe.

DROMIOPSIS ELEGANS, Steenstr. et Forchh., sp.

? *Dromilites elegans* (*elegantulus*), Steenstr. et Forchh. MS.
1859. *Dromiopsis elegans*, Reuss: Fossil. Krabben, p. 15, pl. iv, figs. 1, 2.
1859. *Dromiopsis minuta* (?), Reuss: Fossil. Krabben, p. 13, pl. iv, fig. 3.
1866. *Dromia elegans*, Von Fischer-Benzon: Alter d. Faxekalkes, p. 26, pl. iv, fig. 2.
1867. ,, ,, Lundgren: Faxekalken, p. 11.
1900. ,, ,, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, pl. i, figs. 16, 18, 19.

[1] Reuss: Fossil. Krabben, p. 13, pl. iv, fig. 3.
[2] Op. cit., p. 15, pl. iv, figs. 1, 2.

This species is very variable in form, but the following characters seem to be fairly constant:—

The circumference is more or less elliptical; the ratio between the length and the breadth is generally as 1 : 1·2; the arching often less than in the preceding species, particularly across the posterior part. The size varies from 5 to 20 mm. in breadth. The lateral margins are provided with small, often indistinct teeth, 7–8 in number. The lateral furrow is shallow, but distinct, being defined behind by a small raised border which is generally noticeable even behind the cardiac region. The posterior part of the mesogastric region and the epigastric lobes is well marked and elevated; the last-mentioned are elliptical and situated transversely. The limit anteriorly being often indistinct. On some specimens the anterior angle seems to run out into a fine line, which ends in a small tubercle.

Of this species two types can be distinguished. One of these particularly is more arched posteriorly, and a little broader than long, with the largest breadth a little in front of the middle of the carapace. The posterior margin is short, strongly curved, and nearly smooth. The second type is broader, with its greatest breadth over the middle. The posterior margin is long and faintly curved; it is more or less granulated, the granules being small, thinly and irregularly scattered. Both types, however, pass by many intermediate forms into each other, and seem to appear just as frequently, and thus it is impossible to distinguish between a typical specimen and its variety.

D. elegans is fairly common at Faxe, and still more so at Annetorp. This species appears also in Maestrichtien supérieur at Mont de Saint-Pierre and at Ciply.[1]

Dromiopsis lævior, Steenstr. et Forchh., sp.

? *Dromiopsis lævior*, Steenstr. et Forchh. MS.
1859. ,, ,, Reuss: Fossil. Krabben, p. 16, pl. iii, figs. 4–6.
1866. *Dromia lævior*, Von Fischer-Benzon: Alter d. Faxekalkes, p. 27, pl. iv, fig. 1.
1900. *Dromiopsis lævior*, Steenstrup: K. O. Segerberg, Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, pl. i, fig. 15.

Larger, more strongly and evenly arched than the preceding species. Circumference rounded. The size varies between 25 and 42 mm. The rostrum is broad, triangular, with its borders strongly raised. The orbits are deep. The external angle of the orbit is interrupted by a broad incision which runs outwards into a wide sulcus. The external tooth of the inferior orbital border is considerably larger than the inner one. The antero-lateral margin begins a little below the inferior orbital border, and its teeth are generally confluent, forming a sharp ridge which is divided by the occipital furrow; both serrations are pointed anteriorly and blunt posteriorly. The posterior margin is somewhat curved inwards. Both the occipital furrow and the lateral furrow are shallow; the last-mentioned is broad, defined behind by a sharp crest, which is

[1] Pelseneer: Decapod. du Maestricht, p. 172.

pointed at the lateral margin, and is continued on to the inferior surface. The epigastric lobes are placed transversely and provided with small prominences. Between these and the antero-lateral margin there are some elevated tubercles, arranged in a row. From an area in the middle of the anterior lateral region, which is full of small depressions and nearly circular in shape, another row of similar tubercles runs in a curve backwards and inwards. The mesogastric lobe is only distinct posteriorly by its conspicuously raised surface. The middle area of the antero-branchial lobes is well marked by the dotted elevation already referred to in the description of the genus. Otherwise the surface of the carapace in the cast is quite smooth, and this is also the case when the shell is preserved.

Of this species one specimen appears with the claw belonging to it, although this is incompletely preserved.[1] The shell of this species is smooth, except a few granules on the shortest side; the cast is more or less reticulated. The claw referred to in Segerberg's paper, p. 17, pl. ii, fig. 2 belongs probably to this species. Only rarely met with at Annetorp and Faxe.

DROMIOPSIS? DEPRESSA, K. O. Segerberg, 1900.

1900. *Dromiopsis? depressa*, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, p. 18, pl. ii, figs. 3, 4?

Of this species only one specimen was obtained from Annetorp. The rostrum is not preserved. The specimen is decorticated. The form of the carapace is nearly pentagonal; breadth 26 mm. The distance from the superior orbital border to the posterior margin is 24 mm. In front of the lateral furrow the carapace is strongly arched; behind the same it becomes narrower, with the lateral parts depressed. The orbits are small, narrow, and transverse. The two teeth on the inferior orbital border are of nearly equal size. The antero-lateral margins commence in a line with the inferior orbital border; in front of the occipital furrow the margin is marked by a prominence and is curved; behind the same it is prolonged forwards into a tooth or point, but otherwise (as on the postero-lateral margins) it is only faintly marked, and curved inwards. The posterior margin is long and slightly curved. The occipital furrow is very indistinct, particularly in its inner course. The lateral furrow (*Sl.*), on the other hand, is distinct, but very shallow, without any well-defined margin. Behind the cardiac region there is a transverse depression. Otherwise the details of the carapace are fairly similar to the preceding species.

This species is in some respects very similar to *Dromia lator*, a recent form from the West Indies.[2] But as only one specimen of the former has been found without a rostrum, and as on the whole it is nearly related to *D. lævior*, I have (with some doubt) referred it to the genus *Dromiopsis*.

In the collections from Faxe, K. O. Segerberg has figured a very incomplete specimen, which he thinks is probably a younger form of this species.

[1] K. O. Segerberg: op. cit., pl. ii, figs. 1, 2.
[2] Loc. cit., fig. 5.

Dromiopsis Birleyæ, H. Woodw., sp. nov. (Pl. XII, Figs. 1*a*, *b*.)

Description.—Carapace broader than deep (16 mm. broad and 12 mm. deep); antero-lateral border slightly concave; frontal margin prominent, with a central depression. Lateral margins rounded; postero-lateral margin sloping inwards; posterior margin (8 mm.) broad and nearly straight; surface sparsely granulated, but generally smooth; with the exception of the epigastric prominences, and the posterior margin of the mesogastric region, the lobes of the carapace are generally very obscurely defined; the cervical furrow (*Sc.*) is most distinct and is very slightly curved; the lateral furrow (*Sl.*) is faintly rugose, but less distinct than the cervical furrow; at the base of the mesogastric lobe is a short granulated band in front of the cervical furrow, and two small pointed prominences (divided by the median furrow), the points directed backwards, each being marked by a minute tubercle; the cardiac region is depressed and only faintly outlined, its surface being marked by three small equidistant tubercles, two in front and one behind; four small tubercles mark the border of the antero-branchial lobe, and three the antero-lateral border. The two rounded prominences near the anterior border of the epigastric lobes are very distinct. The rostrum, which is rounded, is bent downwards between the orbits, and is deeply indented by the frontal furrow. The orbits are elongated transversely, and are open internally towards the rostrum.

Remarks.—Two apparently full-sized specimens of this well-marked species (16 × 12 mm.) are in Miss Birley's collection, also one young specimen measuring 9 mm. in breadth by 6 mm. in depth; all three are preserved in hard compact limestone, which contains also traces of the limbs. The species is distinguished by its well-marked form, being broader in proportion to its depth than *D. rugosa*, although specifically they are no doubt nearly related. The rostral and frontal border is less prominent in *D. Birleyæ*, and the posterior margin is wider and straighter than in *D. rugosa*. All three examples have been decorticated.

I dedicate this species to my friend Miss Caroline Birley, who has given so much time and attention to the study of geology and palæontology both at home and abroad, and whose private collection bears testimony to her devotion to science.

Formation and Locality.—Hard Upper Cretaceous Limestone (Danian) of Faxe: coll. Miss Birley.

Dromiopsis Coplandæ, H. Woodw., sp. nov. (Pl. XII, Figs. 2*a*, *b*.)

Description.—Carapace slightly broader than deep (9 × 7 mm.); anterior border semicircular; frontal region broad, depressed; orbits large, prominent, visible from above, and placed somewhat diagonally; enclosed externally, but open towards rostrum; postero-lateral margins contracting rapidly towards the posterior margin, which is narrow, only 3 mm. wide, and emarginate. Cervical furrow distinct; lateral furrow faint, but more strongly marked on the margin of carapace; antero-lateral margin very bluntly dentated or undulated; mesogastric and epigastric lobes slightly prominent; carapace generally smoothly rounded and lobes obscure.

Remarks.—This is a very well-marked glabrous form and quite distinct in outline from any of the other species; the sides being narrower and contracting posteriorly, and more rounded and depressed in front; with the orbits visible from above, which is not the case in any other species of *Dromiopsis*.

Among the smaller specimens of *Dromiopsis* I have detected a minute, very round, smooth form; the carapace is 6 mm. broad and 5 mm. deep; it agrees generally with the larger example (Figs. 2*a*, *b*). The cardiac region in this small specimen is more clearly defined, and has three equidistant tubercles on its surface; the orbits are large and prominent, and the outline of the back is very globular; this latter character is probably due to its being a young individual.

I dedicate this species to Miss Copland, who participated with Miss Birley in her geological labours and collected many of the specimens with her own hands at Faxe.

Formation and Locality. — Uppermost Cretaceous (Bryozoa Chalk), Faxe: original specimens in Miss Birley's collection.

Homolopsis transiens, K. O. Segerberg.

1900. *Homolopsis transiens*, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, pl. ii, figs. 6–8.

K. O. Segerberg obtained several specimens of this species both from Annetorp and Faxe, preserved as casts, nearly all, curiously enough, without frontal or lateral margins being preserved (cf. Carter, Decapod. Crust., p. 22).

Anteriorly depressed, otherwise nearly even; the length about 22 mm. (on the larger, figured specimen). Rostrum narrow, triangular, and depressed, provided with a small tubercle on each side. Lateral and posterior margins long, straight, elevated into a ridge. Occipital furrow deep and broad at the sides, narrower between the mesogastric and the urogastric lobes, and having two pointed elevations in the centre. Lateral furrow narrow, faintly defined; nearly straight on each side of the middle line; directed outwards and forwards. The different regions are all very conspicuous and limited by deep sulci. The epigastric lobes are marked by two distinct tubercles. One sees three other similar tubercles on the protogastric lobes. The mesogastric lobe is well defined on all sides. The urogastric lobe is pointed at the sides. The cardiac region is pentagonal and elevated. The antero-branchial lobes are divided on the inner side into two parts, of which the superior one is the shorter. The postero-branchial regions are triangular and large; there is a tubercle on the inner posterior part. The superior surface is more or less thinly and irregularly granulated. On a younger specimen (op. cit., pl. ii, fig. 7) similar granules can be seen, particularly on the mesogastric and cardiac lobes. On an older one (op. cit., pl. ii, fig. 6) one sees these granules both on the cardiac and postero-branchial lobes arranged transversely in short rows; on account of this arrangement the casts have a somewhat ridged appearance. Another old specimen, on the contrary (pl. ii, fig. 8), has the posterior part nearly smooth, and the tubercles on

the protogastric lobes are but little conspicuous. (This is also the case with a single specimen preserved in Miss Birley's collection.)

This species is in many respects very similar to *H. Edwardsii*, Bell,[1] from the Gault and Greensand of England, a very peculiar form, to a knowledge of which the late Mr. James Carter[2] has made some very valuable contributions. In regard to the granulation on the postero-branchial lobes the species from the Uppermost Chalk (here described by Segerberg) is very similar to the Tertiary genus *Dromilites*,[3] which is also closely related to *Homolopsis*, and seems thus to be a transitional form between these two genera.

A single, very imperfect carapace is preserved in Miss Birley's collection from the Danian of Faxe.

CARPILIOPSIS.

CARPILIOPSIS ORNATA, Von Fischer-Benzon, sp. (Pl. XII, Figs. 5*a*, *b*.)

1867. *Carpiliopsis ornata*, Von Fischer-Benzon, sp.: Alter d. Faxekalkes, p. 28, pl. ii, figs. 1–3.

1900. ,, ,, K. O. Segerberg: Geol. Fören. I Stockholm Förhandl., Bd. xxii, H. 5, p. 28, pl. iii, figs. 15, 17, 18?

DESCRIPTION.—The carapace is sub-elliptical, equally convex longitudinally; the lateral margins are acute; the antero-lateral margins are short, rounded, and curved backwards. The postero-lateral margins are longer and are curved inwards. The orbits are oval, and when seen from above marked by emarginations on either side (Pl. XII, Fig. 5*a*) of a broad, bluntly rounded, and slightly notched rostrum (Pl. XII, Fig. 5*b*). The posterior margin is narrow and emarginate. The upper surface of carapace is punctate, and ornamented by raised lines and tubercles peculiar to the species; the general surface is very minutely ornamented with microscopic granules.

The mesogastric lobe is marked by two minute tubercles and a small, short, raised line behind, probably affording the only evidence of the presence of the cervical furrow; there is a slight trace of a median ridge and furrow, and a rather larger tubercle marks the centre of each epigastric lobe. One tubercle on either side and a few minute granules scattered over the protogastric and hepatic regions are the only interruption to the otherwise smooth anterior surface of the carapace. The cardiac region bears three minute tubercles, and is enclosed on either side by a lyre-shaped ridge and furrow, which bending back upon itself forms the short lateral furrow.

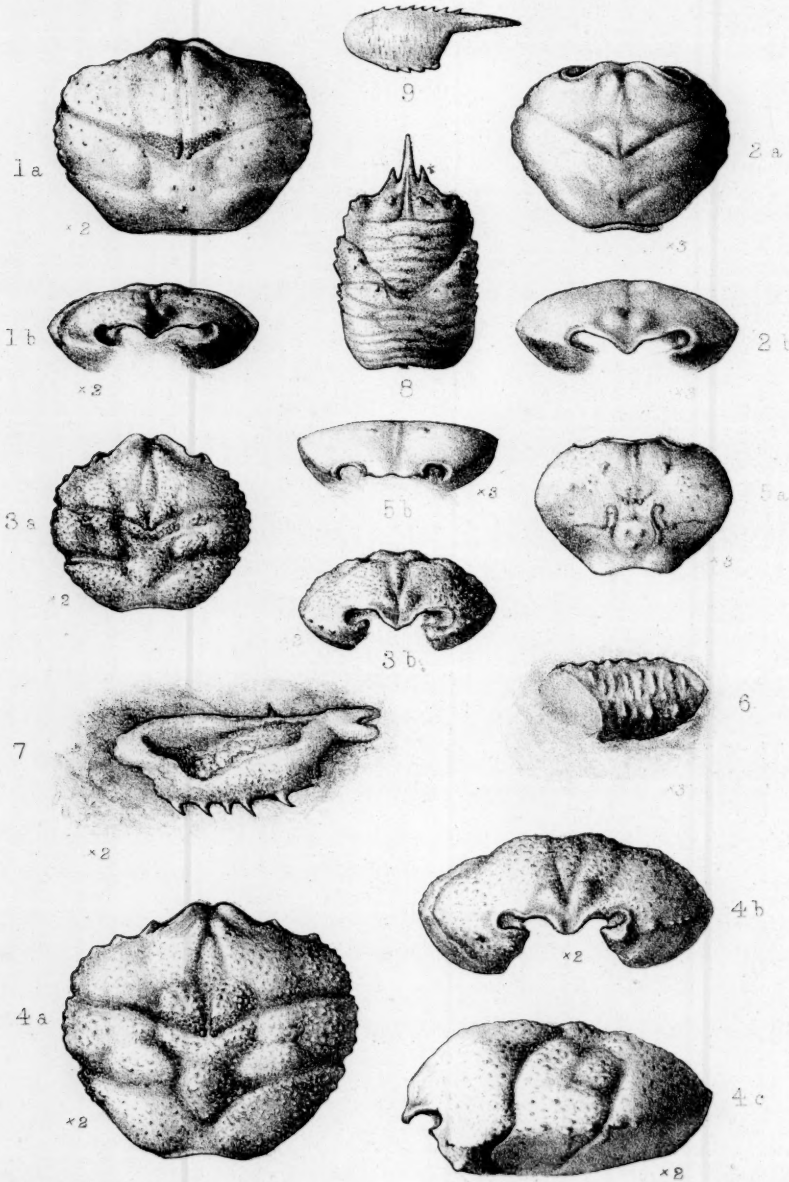
REMARKS.—This well-marked form is represented by two examples in Miss Birley's collection, the larger measuring 12 mm. in breadth by 7 mm. in depth, the lesser example being 9 mm. broad and 6 mm. in depth. Both are from the uppermost Cretaceous formation of Faxe, Denmark.

The following is a list of the species of Crustacea from Faxe recorded by K. O. Segerberg and H. Woodward:—

[1] Bell, Crust. of Gault and Greensand: Mon. Pal. Soc., 1862, p. 23, pl. v, figs. 1, 2.

[2] Carter: Decapod. Crust., 1898, p. 21.

[3] Bell: Crust. of London Clay, p. 27.



G.M.Woodward, B.Potter } del. et lith. West, Newman imp.

Cretaceous Crustacea from Faxoe.

Galatheidæ.

Galathea strigifera, Steenstr. Danian: Annetorp and Faxe.
* ,, *munidoides*, K. O. S. Danian: Faxe.
**Munida primæva*, K. O. S. Danian: Faxe.

Dromiacea.

**Dromiopsis rugosa*, Schlüt., sp. Danian: Faxe.
,, *minor*, Von Fischer-Benzon, sp. Danian: Annetorp and Faxe.
,, *elegans*, Steenstr. et Forchh., sp. Danian: Annetorp and Faxe.
,, *lævior*, Steenstr. et Forchh., sp. Danian: Annetorp and Faxe.
,, *depressa*, K. O. S. Annetorp and Faxe.
* ,, *Birleyæ*, H. Woodw., sp. nov. Danian: Faxe.
* ,, *Coplandæ*, H. Woodw., sp. nov. Danian: Faxe.
Plagiophthalmus pentagonalis, K. O. S. Faxe.
**Homolopsis transiens*, K. O. S. Annetorp and Faxe.

Raninoidea.

Raninella Baltica, K. O. S. Faxe.

Oxystomata.

Necrocarcinus senonensis, Schlüt., sp. Annetorp and Faxe.
,, *insignis*, K. O. S. Annetorp.
,, *bispinosus*, K. O. S. Saltholm's Chalk: Limhamn.

Cyclometopa.

Titanocarcinus, sp. Annetorp.
**Carpiliopsis ornata*, Von Fischer-Benzon, sp. Annetorp and Faxe.
Xanthilites cretaceus, K. O. S. Annetorp.
Panopeus faxensis, Von Fischer-Benzon, sp. Annetorp and Faxe.
,, *subellipticus*, K. O. S. Faxe.
,, *incertus*, K. O. S. Annetorp and Faxe.

Note.—Those marked by a * are represented in Miss C. Birley's collection.

EXPLANATION OF PLATE XII.

Crustacea from the Uppermost Chalk ('Danian') of Faxe, Denmark.

Fig. 1.—*Dromiopsis Birleyæ*, H. Woodward, sp. nov. × 2 times nat. size.
a, dorsal aspect of carapace or cephalo-thorax.
b, frontal aspect of carapace, showing orbits and rostrum.
,, 2.—*Dromiopsis Coplandæ*, H. Woodward, sp. nov. × 3 times nat. size.
a, dorsal aspect of carapace.
b, frontal aspect of carapace, showing orbits and depressed rostrum.
,, 3.—*Dromiopsis rugosa*, Schlotheim, sp. Small, round, much granulated variety. × 2 times nat. size.
a, dorsal aspect of carapace.
b, frontal aspect of carapace, showing arched form of carapace and depressed rostrum.
,, 4.—*Dromiopsis rugosa*, Schlotheim, sp. Typical, most abundant form. × 2 times nat. size.
a, dorsal aspect of carapace.
b, frontal aspect of carapace, showing rounded form of back.
c, side view, showing inflated form of frontal region and strongly marked, transverse cervical and lateral furrows.
,, 5.—*Carpiliopsis ornata*, Von Fischer-Benzon, sp. × 3 times nat. size.
a, dorsal aspect of carapace, showing the peculiar lyre-shaped markings on the centre enclosing the cardiac region.
b, frontal aspect of carapace, showing the broad blunt rostrum which widely separates the small orbits.
,, 6.—Portion of a chela. × 3 times nat. size.
,, 7.—Portion of a chela. × 2 times nat. size.
,, 8.—*Galathea munidoides*, K. O. Segerberg. Dorsal aspect of cephalo-thorax. × 4 times nat. size.
,, 9.—*Galathea munidoides*, K. O. Segerberg. Penultimate joints of chela. × 4 times nat. size.

III.—On the Rate of Increase of Underground Temperature.

By Professor W. J. Sollas, LL.D., D.Sc., F.R.S.

In the 22nd Report of the Committee appointed to investigate the rate of increase of underground temperature, read this year before the British Association in Glasgow, some remarks previously made by me are animadverted upon; and as the Secretary, Professor Everett, has invited me to discuss the matter with him, I take the opportunity of entering somewhat more fully into the question of conductivity than has hitherto seemed necessary. We read in the Report ". . . . in view of the fact that the President of Section C last year characterised the variation in the British Isles 'from 1° in 34 feet to 1° in 92 feet' as 'a surprising divergence of extremes from the mean,' it is well to emphasise the connection between gradient and conductivity. If there is anything like uniformity in the annual escape of heat from the earth at different places, there must necessarily be large differences in geothermic gradients, since the rate of escape is jointly proportional to the gradient and the conductivity."

So well known a fact as the statement in the last sentence seems to me scarcely to require emphasis, since it must assuredly be present in the mind of everyone capable of discussing the question: but it is not sufficient to make general statements of this kind; it must also be shown, if the argument is to be of any real value, that the known divergences of extremes from the mean may be definitely connected with known differences in conductivity. Hitherto this has not been attempted, and in the Address to Section C last year it was expressly stated that "many cases exist which cannot be explained in such a manner, but are suggestive of some deep-seated cause, such as the distribution of molten matter below the ground." Before proceeding to enter into calculations which may illustrate this statement, it may be worth while to observe that we have no evidence to suggest, much less to prove, that "there is anything like uniformity in the annual escape of heat from the earth at different places"; the indications are altogether to the contrary: the mere existence of volcanos obviously invalidates the statement as an absolute affirmative, and ancient laccolites show that in past time at least concealed sources of heat have existed not very remote from the surface.

If, then, there is *not* uniformity in the annual escape of heat from the earth at different places it may be thought unnecessary to labour the question in greater detail, yet in view of the importance of the subject to geological inquiry it may be worth while to consider some special cases. If we turn to the "Summary of the Results in the first 15 Reports by Professor Everett" (1882) we shall find a table of mean conductivities from several kinds of rocks given in C.G.S. measure, from determinations made by Professor Herschel. but these, following the direction of Professor Everett, must be multiplied by a correcting factor 1·4 for use in calculation. For our purpose we select the following:—

Rock-salt	...	·0113	Clay	...	·0025
Sandstone	...	·0060	Shale	...	·0019
Flagstone	...	·0046	Coal	...	·0008

Rock-salt heads the list, and consequently in borings made through this mineral the thermometric gradient should be lower than the average. If, now, we turn to the results given on p. 88 of the British Association Report for 1882 we find that the deep Sperenberg boring, which passed chiefly through rock-salt, shows a temperature increase of 1° for 51½ feet, and this result is regarded by the Committee as so remarkably accurate that the effect of quadrupling it when calculating a mean rate is thought worthy of consideration. On p. 84 we read, "The Sperenberg bore, near Berlin, in rock salt, with a depth of 3,492 English feet . . . . gave an average of 1° in 51·5 feet. This result is entitled to special weight, not only on account of the great depth, but also on account of the powerful means employed to exclude convection." The mean result for all observations given in the same Report is 1° for 64 feet, which was corrected in a later Report to 1° for 60 feet.

Thus, the gradient of the Sperenberg bore, so far from being below the average, such as the conductivity of rock-salt would have led a believer in the uniform rate of loss of heat to expect, actually rises above it. The average rate at which heat escapes through the earth is given in the Report (1882) as 41·4 gramme degrees annually through each square centimetre of a horizontal section of the earth's substance. There is an error in this number, no doubt typographical; it should read 51·4.

Let us calculate from the data afforded by Sperenberg the average flow of heat through the rock-salt of that district. The gradient of 1° in 51·5 feet reduces to 0·0003537 of a degree Centigrade per centimetre. The conductivity of rock-salt, according to the Report, is $·0113 \times 1·4 = ·01582$ and $0·0003537 \times ·01582 = 55955 \times 10^{-10}$, which is the flow of heat in gramme degrees per second across one square centimetre, or $55955 \times 315 \times 10^{-4} = 176·2$ gramme degrees per year per square centimetre. In other words, if the influence of conductivity be fairly considered, it leads to the conclusion that the rate of escape of heat at Sperenberg is more than thrice as great as that of the mean (51·4). The data at our disposal in the case of coal-mines do not appear to be sufficient for the purposes of discussion; all that can be said is, that while the sinkings were made in similar rocks the temperature gradients obtained differ widely among themselves. Without detailed information of the thickness and nature of the various beds passed through in the several cases from which the average is reduced, calculation is impossible.

A matter of extreme importance has, however, to be mentioned in this connection. In the Report for this year we read (p. 6, separate copy): "In some condensed reports of Bergrath Köbrich's communication (but not in the full paper as given in 'Glückauf'), the irregularities are attributed to chemical action in the coal seams, causing in some cases a heating and in others a cooling; but in the absence of more direct evidence this explanation seems rather

forced." Putting aside the possibility of cooling, the effect of chemical action in evolving heat from coal-seams is well known, and an important paper on the subject was read in 1899 by Dr. Haldane and Mr. Meachem before the Society of Mining Engineers. It was clearly shown by these investigators that the heat resulting from the oxidation of marcasite in coal-seams is three times as much as is required to account for the total rise in temperature which the air of the ventilating current undergoes in passing through the mines. Dr. Haldane, who has given great attention to this subject, informs me that he considers the effect of this chemical action has been too little considered, and that he has no doubt it has led to an exaggerated estimate of the mean thermometric gradient in coal borings. While recognizing the great value of the Reports issued by the Committee of which Professor Everett is Secretary, to whom all geologists must feel grateful for the investigation of a question which is of the first importance to their inquiries, I still consider that, owing to various disturbing factors, the average rate of temperature increase with descent into the crust may have been overestimated, and that divergence from the mean may in some cases be connected with an irregular distribution of molten matter below the ground.

IV.—Circulation of Salt and Geological Time.

By Professor J. Joly, M.A., D.Sc., F.R.S.

In the Geological Magazine for August I gave the major limit to the period of time we can assign to the geological age of the Earth by the solvent-denudation method, when it is assumed that *all* the chlorine of rivers is derived directly from the ocean, and that all such chlorine (falling, as assumed, in rain) carries its full complement of sodium from the ocean. The major limit with these assumptions is 141 million years. A second estimate is given on the more moderate assumption that one-third the amount of chlorine in rivers is derived from the sea and brings with it its full equivalent of sodium; this affords 105 millions of years as the age. Finally, there is the original estimate based on a 10 per cent. deduction from the chlorine of rivers as rain-borne, affording 96 millions of years.

Among such numbers we may take our choice. Outside the upper limit we cannot go if we rely on the mean river analyses of Sir John Murray, and of course accept the principle of uniformity involved. It is a perfectly simple matter, which may be stated as follows:—There is a large excess of sodium over chlorine appearing in the mean analysis of 19 chief rivers of the world. The numbers are 157×10^6 tons of sodium and 84×10^6 tons of chlorine carried to the ocean per annum; or, dividing by the atomic weights, the relative numbers of ions are as 68 sodium to 24 chlorine. The consequence is that even if the whole of the chlorine be supposed derived from the sea and none at all from denudation, and to reach the rivers fully satisfied with marine sodium, there remains over such an excess of sodium that the age *cannot exceed* 141×10^6 years.

Now this was fully pointed out in my previous paper; it should be perfectly well known to Mr. Ackroyd; but we find still that Mr. Ackroyd maintains that "the chemist's convention of taking chlorine as a measure of sodium in rain- and river-water is serviceable, and cannot involve more final error in connection with this problem than that indicated by the ratio of these elements in sea-water."

As regards the first part of this statement, we have seen that "the chemist's convention" would give hopelessly erroneous results if applied to river analysis. As to the ratio of the chlorine and sodium in sea-water, this has nothing to do with the matter beyond indicating that as there is a large excess of chlorine over sodium in the sea we may expect a similar excess to obtain in rain-water. We may also observe that if "the chemist's convention" were applied to sea-water an entirely erroneous result would be obtained on the other side; the sodium would be greatly overestimated.

On the strength of this convention, however, Mr. Ackroyd again quotes his analyses of the Aire (a small coastal stream), and, preferring it to the mean analysis of the large rivers, again arrives at some thousands of millions of years. That, following similar reasoning, a stream could be found giving an infinite age to the earth, goes without saying. Why will Mr. Ackroyd not have the 19 rivers? The only objection I have heard urged against them (and it is one of considerable weight) is that they are not numerous enough. This is Professor Sollas' criticism.

Coming now to the question of the origin of the salts of inland seas, a question which Mr. Ackroyd has raised in connection with the allowance proper for rain-borne sodium, I see in his last paper in this Magazine that Mr. Ackroyd would explain the wide differences in chemical composition of these waters by the effects arising from concentration. The enormous amounts of precipitated salts required by this hypothesis must, however, here be considered. Let it be assumed, as he desires, that sea-water reaching closed lakes in rain-water has concentrated until the balance between 20 per cent. of $MgCl_2$ and 5 per cent. of NaCl is attained. In sea-water there is but 0·38 per cent. of $MgCl_2$. There is, on the other hand, 2·73 per cent. of NaCl. To reach the required percentage of $MgCl_2$ a concentration of 53 times the original is necessary. This involves a concentration of the NaCl amounting to 145 per cent. Deducting the 5 per cent. that remains in solution, but remembering that NaCl will by no means be the only salt precipitated, also allowing the small imported amount of $MgSO_4$ as a set-off against dolomitizing actions, we finally arrive at the conclusion that the precipitated salts amount to well over $1\frac{1}{2}$ times the entire mass of the existing inland sea. This is the *least* quantity we must look for in such a case, for it is the amount thrown down if the concentration had only just attained the existing state.

I do not contend that the existence of such masses is out of comparison with known salt deposits; but their absence in the particular localities would constitute a fatal objection to supposing such extreme

concentration. When it is remembered that the Dead Sea sinks to depths of 400 metres we may realize that very great deposits must be supposed existing immediately around and beneath its waters if Mr. Ackroyd's views are to be entertained. The fact quoted by Mr. Ackroyd that "common salt in the southern parts of the lake forms quite a paste" will evidently not suffice.

It is needless to quote here the views of geologists on this question. The observations of Lartet (Bull. S.G.F., [2] xxiii, p. 719) quoted by De Lapparent show that "tous les sels contenus dans l'eau de la mer Morte et celle du Jourdain sont également (à l'exception peut-être du brome) renfermés dans les eaux des sources chaudes du même bassin, notamment celles de Zara, de Callirhoë, et d'Emmaüs" (vol. i, p. 488). The absence of iodine, so characteristic of sea-water, the presence of bituminous and sulphurous odours, the very local variations in composition, further lead M. de Lapparent to the view that the intervention of sea-water cannot be looked for in accounting for its composition; but that it represents a fresh-water lake modified by volcanic agencies of comparatively recent date.

Having no leisure to discuss the matter further, I would close my remarks by stating once more that the carriage of sea-salts into many inland lakes is very certainly a fact. The difference between Mr. Ackroyd's and my own views on the matter is one of degree only. If my own original estimate, that 10 per cent. of river chlorine is from the ocean, were correct, this would involve considerable importations of sea-salts in process of time into inland waters.

V.—The Sequence of the Tertiary Igneous Rocks of Skye.

By Alfred Harker, M.A., F.G.S.

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THIS communication is the outcome of work carried out during the years 1895–1901 in the service of the Geological Survey of Scotland. Although this systematic work has been confined to the Isle of Skye, information incidentally acquired, and the published literature of the British Tertiary rocks, indicate for the conclusions arrived at a much wider application. In this place the results must be set down without the detailed observations upon which they are based.

Here, as in numerous other areas and at various geological periods, igneous activity has manifested itself successively under three different phases, the *Volcanic*, the *Plutonic*, and the *Phase of Minor Intrusions* (often called the Dyke Phase). There is further an important distinction to be observed, neglecting which the whole sequence is thrown into confusion. The various events recorded in the succession fall into two distinct categories of very different orders, which may be termed the *Regional Series* and the *Local Series*. Those of the former class affected a very wide area—perhaps in some cases the whole Brito-Icelandic Province, extending from the

British Isles to beyond the Arctic Circle. The episodes of the Local Series, on the other hand, were closely related to certain special foci of activity, declared at a very early epoch, one of which was situated beneath what is now the mountain district of Central Skye. While events of the two classes often alternated in our area, and are integral parts of one complete record, they may be regarded as in some degree independent and as bound up with two distinct orders of crust-movements, viz. the continent-building and the mountain-building respectively. Of the two parallel series of eruptions, the Regional retained throughout a basic character, while the Local developed wide petrographical differences among the several groups. It follows that the successive episodes of the Regional Series are much more difficult to separate and arrange in order than those of the Local Series, and the following condensed scheme is confessedly imperfect, especially as regards the basic lavas and the basic dykes.

(0) Pre-Volcanic Phase: *Local Series.*—Here may be noticed certain plutonic intrusions nowhere exposed at the surface and known only from fragments in the volcanic agglomerates. They are confined to the central mountain district, and include, in order, (*a*) gabbro and (*b*) granite.

(1) Volcanic Phase.—Regional activity almost continuous; local chiefly confined to two well-marked episodes.

Regional Series.—Fissure-eruptions of basic (with some sub-basic) lavas throughout the region. Besides the prevalent olivine-basalts, there are some hypersthene-basalts, augite-andesites, etc., but no ordered sequence has been made out.

Local Series.—Central, not fissure-eruptions.

(*a*) Paroxysmal outbursts at certain centres, marked by great accumulations of volcanic agglomerate; the large vents confined to the mountain district. The chief masses of agglomerate underlie all the lavas, and thus represent the earliest overt manifestation of igneous activity.

(*b*) Eruptions, only in part paroxysmal, of intermediate and acid rocks in one limited area on the northern border of the Cuillins. Generalized sequence: (i) trachytes, (ii) rhyolitic tuffs and breccias, (iii) rhyolites. This group is intercalated as a local episode in the midst of the basic lavas.

(2) Plutonic Phase.—Regional activity in abeyance; local at maximum of intensity and at the same time narrowly localized.

Local Series.—Plutonic intrusions in the forms of complex laccolitic masses and bosses. Three groups, in order of increasing acidity, with little or no intervals.

(*a*) Peridotites of the south-west Cuillins; viz., olivine-anorthite rocks, picrites, and typical peridotites, including dunite.

(*b*) Gabbros of the Cuillins, etc.

(*c*) Granites and granophyres (plutonic) of the Red Hills.

(2 to 3) Transitional Phase, *Local Series* only.—The phase of Minor Intrusions shows, as compared with the Plutonic, a reversal of order among the groups of local intrusions. There seems to have

been a certain *critical epoch*, at which in some places basic and acid rocks were intruded almost simultaneously, the basic, however, being slightly the earlier. Remarkable reactions resulted between the two rocks so intimately associated. Here belong :—

Composite sills and dykes, composed of basic and acid rocks, usually with triple symmetry ; occurring along a belt outside the border of the Red Hills.

(3) Phase of Minor Intrusions in the form of sills, sheets, and dykes. Resumption of regional activity in a new form (intrusive instead of extrusive); local activity at certain epochs. Waning intensity indicated during this phase by generally diminishing volume of intrusions, both individually and as groups, and, at least in the Local Series, by intervals of quiescence.

Regional Series.—Rocks still exclusively basic and (exceptionally) sub-basic, so that no law of chemical variation in time can be laid down.

(*a*) Great group of basic sills. These are by far the most important intrusive rocks in the whole suite, making up more than half of the total thickness of the basaltic group over most of the area, besides appearing in considerable force in the underlying Jurassic. Their intrusion constituted the first episode of the Phase of Minor Intrusions. They are here included in the Regional Series as having clearly no relation to the special focus of Central Skye. They are most developed in the north and west of the island, and die out towards the mountains.

(*b*) Basic dykes, mostly with directions near N.W.–S.E., intruded in vast numbers throughout the region at various epochs, the division into successive groups being possible only in a very partial degree. These basic dykes are to be regarded as self-constituted intrusions; others of earlier dates being merely the feeders of lava-flows and sills.

Local Series.—Three chief groups, having restricted areas of distribution, each standing in relation with the corresponding plutonic centre. Order of increasing basicity.

(*a*) Minor acid intrusions (dykes, irregular sills, etc.). Area of distribution a roughly elliptic tract, centring in the granite of the Red Hills but extending beyond, with long axis in the general direction of the dykes (N.N.W.–S.S.E.).

(*b*) Minor basic intrusions. Area of distribution nearly coincident with the gabbro of the Cuillins. The most remarkable set of intrusions takes the form of numerous parallel sheets inclined inwards, towards the centre of the area. In addition there is a radiate set of dykes, partly feeders of the sheets, partly older; also, much less perfectly developed, a tangential set of dykes.

(*c*) Minor ultrabasic intrusions, in the form of a radiate set of dykes; distributed with reference to the Cuillins, or rather to the south-western half of the Cuillin area, where the plutonic peridotites occur.

Subsidiary Groups.—There remain certain groups of dykes, of small importance as regards number and magnitude, concerning which more data are needed. They belong in all cases to very late episodes, but their precise places in the sequence have not been satisfactorily fixed.

(*a*) Trachyte and trachy-andesite dykes. Most of these, occurring about Broadford and in the Sleat district, seem to belong to a group which has its chief area of distribution farther south-east, on the Scottish mainland, and these rocks therefore cannot be attached to the local series of the Skye focus.

(*b*) Augite-andesite dykes, usually with glassy base, and others of acid pitchstone. Dykes and sills of these two rocks are more numerous in the Isle of Arran, where, as Professor Judd has shown, the two types are closely associated, sometimes in composite intrusions. In Skye the known occurrences of acid pitchstone all lie on a narrow belt passing through the granitic tract and having a direction corresponding with that of the dykes themselves. They thus seem to connect themselves with the Local Series as a final and feeble recrudescence of activity about the acid Red Hills centre.

The reversion in the closing stages to intermediate and finally to acid types seems to suggest a new reversal of the order of eruptions, and the composite intrusions (augite-andesite and acid pitchstone) of Arran may perhaps be taken as pointing to a second critical epoch during transitional conditions. These sporadic manifestations of an igneous activity nearing its point of extinction do not, however, afford any very firm ground for such deductions.

VI.—Geological Notes on the Neighbourhood of Ladysmith, Natal. No. 1: On some Igneous Rocks.

By Dr. H. Exton, F.G.S.

(Communicated by Professor T. Rupert Jones, F.R.S., F.G.S.)

WRITING from the Station Hospital at Ladysmith, Dr. Henry Exton, F.G.S., has communicated his observations on the geology of the country near Ladysmith, in the northern part of Natal, in letters to Professor T. Rupert Jones. A very noticeable geological feature is the prevalence of an igneous rock (intrusive andesitic diabase) on all the hills from Umbulwana, four miles east by south from Ladysmith, to the famed Spion Kop, sixteen miles west from here.

This rock covers all the hills, in rounded, smooth, and almost polished boulder-like blocks, of a rusty brown hue on the surface, with a clean blue crystalline fracture, and giving out a ringing sound when struck. It is called by the Dutch *yzad-klip* (iron-stone). The hill-sides around about here can be ascended on foot only where a military road has been cleared to the summit. The slopes of the hills are so profusely strewn with the rounded iron-stone blocks that riding along them is impossible, and even walking is a tedious task. The surface of the boulders is generally so rounded and smooth that one has to tread between them, not upon them, as the foot is apt to slide off. Of course, on the summits, where these rocks are in mass, the rounding of the edges is not so apparent, but they are alike weathered to a rich brown colour, very different from the blue crystalline surface of a recent fracture.

In Pearson's "Story of Ladysmith," p. 108, it is stated that in ascending Gun Hill, to capture the Boer guns, the soldiers found that the boulders, rounded and worn by the storms of ages, were slippery to tread on, and occasionally the foot would become wedged between them.

The photograph marked, No. 3, gives a general view of a ridge, on the upper level, near the hospital, from which loose blocks have fallen to the slopes below. The upper portion of the ridge consists of a fine-grained sandstone (? Upper Karoo beds).

On the hill-tops of the district the igneous masses show some flat surfaces, and a further effect of weathering is seen in numerous shallow depressions more or less circular, with a diameter of an inch and a half to two inches.

About half a mile in a north-westerly direction from this hospital some military trenches have been cut across the summit of a low hill. The stones there exposed are similar to the surface-rock of the country (dolerite or diabase) elsewhere; but they vary in size from a mere flake to a ton in weight, and are cemented together by a yellow ferruginous sandy matrix, and each separate stone is encrusted by a coating of the same firmly adherent. The pieces have mostly fairly angular edges without any rounded or water-worn aspect.

It is very probable that this red matrix in which the diabase is imbedded is the result of decomposition. If so, these stones of hard crystalline rock, thinning out to thin sheets (such as the specimens sent), appear to have been either intrusive or overflowing lavas.

Mr. Fred. Chapman, A.L.S., who has kindly examined the specimens sent home, states that the so-called diabase is an altered augite-andesite (porphyrite). The specks of magnetite scattered throughout have decomposed and given rise to the vivid orange-red or brick-red exterior. The weathering action has, no doubt, been accentuated by extremes of temperature.

VII.—On the Origin of the Gravel-Flats of Surrey and Berkshire.[1]

By Horace Woollaston Monckton, F.L.S., V.P.G.S.

In the south-east of England considerable tracts are covered by sheets or patches of gravel. It is mainly composed of flints from the Chalk, has a thickness of, say, from 6 to 20 feet, is generally stratified, and rests upon an uneven surface of the older strata. The top is nearly always flat and inclined at a low angle.

These sheets of gravel lie at various levels: thus, at Cæsar's Camp, Aldershot, there is a large gravel-covered flat the highest part of which is 600 feet above the sea. A little to the north-east there is another flat, named the Fox Hills, at a level of 360–390 feet, and a few miles to the north there are Hartford Bridge Flats, which lie 330 feet above the sea. (These are in Sheets 284 and 285 of the new series one-inch ordnance map.)

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

On the side of the Fox Hills (Sheet 285) there is a sheet of gravel south of Mitchet House, with a level of about 250 feet; and at Eversley, Shinfield, and Hurst, in Sheet 268, there are flat expanses of gravel almost flush with the alluvium of the rivers Blackwater and Loddon, and at levels of 180 to 120 feet.

There are many other sheets of gravel in this neighbourhood, but I have mentioned sufficient to show that there are here a series at very various levels, from the high ground of Cæsar's Camp, Aldershot, down to the level of the alluvium of the rivers which drain the area.

If we continue our course down the Thames we find similar gravel-flats practically down to the present level of the sea.

I have said that these gravels consist mainly of chalk-flints, but they also contain other stones, and a careful examination of these convinced me that the gravels are of fluviatile origin, the nature of their composition depending upon the geological structure of the drainage area of different rivers.[1]

If, then, these sheets of gravel are, as I believe, river gravels, they must all have been originally deposited at the bottom of a valley, and where, as in several of the cases above mentioned, they are now on plateaux or terraces, this position must be due to denudation, which has destroyed the sides of the valleys since their deposition. It is pretty clear that this is the case, for every stage may be found between the gravel terrace in a valley and the gravel-capped plateau with valleys all round it.

There is a good example at Maidenhead, where there are three well-marked terraces of gravel, as shown in a sketch-map by Mr. Whitaker.[2] They are lying on the side of the Thames Valley, but if we follow the highest terrace southwards we find that between Bray Wick and Maidenhead the progress of denudation has been sufficient to make the terrace into a plateau with valleys all round it.

Now it has for some time seemed to me that these gravel-flats may have something in common with the terraces which we see in so many places on the coast and in the fjords of Norway. In the first place there are several points of resemblance—

1. They are formed of gravel and sand.
2. They have a flat and somewhat sloping top.
3. Several flats occur one above the other.
4. Between the flats there is a steep slope.
5. They appear to be mainly the work of rivers.

Now the explanation of the Norwegian terraces which, I believe, finds favour in Norway is as follows :—

The rivers carry with them sand, clay, and small stones, much of which is deposited in the valleys. The remainder sinks to the bottom before the mouths of the rivers in the sea or fjords, and is spread out as a slightly inclined plain where circumstances are

[1] Quart. Journ. Geol. Soc., 1892, vol. xlviii, p. 29 ; 1898, vol. liv, p. 184.
[2] "Geology of London" : Mem. Geol. Surv., 1889, vol. i, p. 391.

favourable. There is often, therefore, at the head of the fjords a shallow which is called *ör*. It ends abruptly a little distance out with a steep slope, where the water all at once becomes some fathoms deep.

Suppose, now, that the land is raised up; we shall have a long, slightly sloping plain of sand and clay, with an abrupt steep slope where the deep water was. The river will at first throw itself over the steep slope as a waterfall, but by degrees it will cut down into the plain and begin to form a new shallow out of the materials. The terraces are just such plains, with so gradual a slope up above the floor of the valleys that they appear horizontal, and ending outside with a steep precipice. At the mouths of most of the valleys, one sees many such terraces rising staircase-like one above the other. These terraces seem to show that the land has rapidly risen many feet at a time, a rise for each terrace, and between them have been long periods of repose, during which the *ör* were formed.

The above is roughly translated from a small Norwegian school geology by Corneluissen, and seems to me to afford a good explanation of the step-terraces of Norway; but does it not also explain the gravel-flats of England? It seems to me that short, rather rapid elevations, separated by long periods of repose, would produce precisely the result which we see in Surrey, Berkshire, and other parts of the country.

The flats are due partly to excavation and partly to deposition. Assume that an elevation of the Thames Valley to an amount of 20 feet took place now. The river would at once begin to cut down its channel to the new level, and in our soft strata its progress back from the sea would be very rapid. We should have a new plain excavated, and the gravel now at the level of the river alluvium would stand up as a terrace; part of it would, moreover, be destroyed, and the materials spread out as a gravel sheet at the lower level. In England, where the rock is soft and easily eroded, the gravel-flats are wide-spread, but in many of the Norwegian valleys the rock is very hard, and the terraces are consequently of very limited extent.

The gravel-flats are best seen on the south of the Thames. North of that river similar flats occur, but there drift questions are much complicated by the presence of glacial beds; indeed, the elevation of the south of England and the deposition of most of the gravels appears to have taken place whilst the north of the country was under glacial conditions, and after they ceased the country seems to have undergone but little further elevation. In Norway, on the other hand, movements of elevation seem to have taken place from time to time up to a much more recent date, and so we find the step-terraces, which are post-Glacial and were formed after southern England had entered upon a period of repose.

The gravel beds upon these flats differ materially from most or all of the older geological deposits of this country. The fact that the stones are to a large extent subangular, and but little water-worn, distinguishes them from the Eocene pebble beds; nor do they resemble

the old breccias with which I am acquainted; but if the suggested explanation be correct the gravels were formed during a period of elevation of the land, whereas most or all of our older deposits were formed during periods of slow subsidence. But, though the explanation now suggested accounts for much of the problem presented to us by the gravels near the Thames, it must be admitted that there are certain facts which it does not explain. Thus, the *Corbicula fluminalis* bed at Crayford and Grays bears so strong a resemblance to deposits which have been clearly formed during a long, slow depression of the surface, that I can only think that at some time this particular part of the Thames Valley sank whilst the remainder was either rising or, more probably, was lying stationary during a period of repose.

The deep channel of drift in the valley of the Cam described by Mr. Whitaker[1] also seems to me to point to an area of local depression.

The conclusions to which I have come are, therefore, four in number:—

1. That the gravels of which I have spoken are river gravels, formed since the country last rose above the sea.

2. That the process of elevation was not continuous, but that short periods of rapid movement were separated by long periods of repose.

3. That the gravel-flats are the work of rivers during the periods of repose.

4. That the earth-movements did not affect the whole area uniformly, and that local depression occurred.

VIII.—Evidences of Ancient Glacier-dammed Lakes in the Cheviots.[2]

By Percy F. Kendall, F.G.S., and Herbert B. Muff, B.A., F.G.S.

IT is uncertain whether Cheviot itself was overridden by extraneous ice, but striæ on Thirl Moor and Baker Crag, recorded by the Geological Survey, probably indicate that that portion of the watershed was overridden by ice from the Tweed Valley, and Professor James Geikie mentions the occurrence of till and striated stones on the tops of the Cheviot Hills at 1,500 feet. The transport of erratics shows movement along both sides of the axis of the range from S.W. to N.E. at some stage of the glaciation. Across the northern end and for at least ten miles down the eastern side, however, a distribution of erratics from the Tweed Valley, together with other indications to be mentioned, points to an ice-flow veering round through easterly to a north to south direction. Our observations go to confirm the above conclusions with respect to the area north and east of Cheviot.

During a few days spent in the district, we observed certain features which throw much light on the later stages of the Ice Age

[1] Quart. Journ. Geol. Soc., 1890, vol. xlvi, p. 333.

[2] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

in this area. Mr. Clough mentions[1] "dry, steep-sided little valleys crossing over watersheds, which do not appear to lie along lines of weakness or the outcrops of soft beds. It is suggested that they might have been formed by streams from glaciers."

Some of the valleys observed by us run along the sides of hills or occur as loops detaching portions of the walls of valleys, and the general characters of similar valleys have been described by us separately.[2] Their mode of occurrence, and the relations to the relief of the country as well as to the position occupied by the ancient ice-sheets, show that they can be ascribed only to the overflow of water from lakelets held up by an ice-barrier. In the country between Yeavering Bell and Ingram we found that each of the spurs separating the valleys which radiate from Cheviot was cut across by one or more sharp gorge-like channels, draining, with one significant exception, to the south. The spur between Roddam Dean and the Breamish River is cut, near Calder Farm, by a channel, bounded on the east by the moraine, draining to the south, but a higher portion of the same spur is traversed by a channel draining in the opposite direction, i.e. to the north.

The highest member of a series across any given spur is usually just above the boundary of the drift, containing extraneous boulders. At the outlets of the valleys there are in several cases deltas, represented by masses of gravel.

Conclusions.—The existence of the series of overflow channels points clearly to the former presence of a chain of small lakes held in the radial system of valleys of the Cheviots by a barrier of ice. The ice-stream, by the boulders which it bore, may be inferred to have swept round the end of the Cheviots out of the Tweed Valley. The margin of the sheet at its maximum extension rose to about 1,000 feet along the arc from Yeavering Bell to Brands Hill, beyond which it may have declined. Along the south-eastern slopes of the Cheviots, another extraneous glacier swept in a north-east direction. Where their confluence took place, or whether they were not in succession rather than simultaneous, is not easy to decide, but the Roddam Burn channel points very clearly to the preponderating influence of the southern stream, while the Calder Farm overflow lower down the same ridge shows by its southerly slope that the northern ice later acquired the mastery. If the two glaciers were confluent, then the overflowing waters of the lakes must have been discharged either beneath the ice, as at present happens to the overflow from a chain of ice-dammed lakes on the Malaspina glacier, or over the top of the ice.

An important and unexpected result of our brief examination has been the discovery that while 'foreign' ice was rising along the flanks of the Cheviots to an altitude of 1,000 feet, not only were the spurs free from any native ice-sheet, such as Cheviot or

[1] "The Geology of the Cheviot Hills": Geol. Surv. Mem.

[2] P. F. Kendall, "On Extra-morainic Drainage in East Yorkshire": Brit. Assoc. Rep., 1899. A. Jowett & H. B. Muff, "Preliminary Notes of the Glaciation of the Bradford and Keighley District": ibid., 1900.

Hedgehope might have been expected to support, but even the lower ends of the intervening valleys were occupied, not by great native glaciers, but by lakes.

The conditions thus described may have some relation to the fact that, while the porphyrites of the Cheviots have furnished the most abundant types of erratics in the Drift of the Yorkshire Coast, the granite, if present, which is not quite certain, is very rare.

IX. — Note on the Volcanic Agglomerate of Forkill, Co. Armagh.

By Joseph Nolan, M.R.I.A., late Senior Geologist (retired), Geological Survey of Ireland.

In a paper by Messrs. J. R. Kilroe and A. M'Henry, M.R.I.A., which appeared in vol. lvii of the Q.J.G.S., published last August. the following statement concerning the above rock is made: "In parts they [the rock masses] consist of brecciated slate or brecciated granite and felsite, the fragments being embedded in a scanty andesitic matrix." Now this description is quite erroneous, the great and almost unique characteristic of the Forkill agglomerate being that the greater portion is made up of non-volcanic materials—in some places of granite pieces for the most part, in a groundmass of finely comminuted material of the same rock, and in others of Silurian slate fragments in a correspondingly derivative base. This I have described long ago in the official memoir to accompany Sheet 70 of the Geological Survey Map of Ireland, as also in the following papers: "On a Remarkable Volcanic Agglomerate near Dundalk" (J.R.G.S., Ireland, new series, vol. iv, pt. 4) and "On the Ancient Volcanic District of Slieve Gallion" (Geol. Mag., Dec. II, Vol. V, October, 1878).

Recently Sir Archibald Geikie, D.C.L., has examined this district, and the results of his investigations are published in his book on the "Ancient Volcanoes of Great Britain," vol. ii, p. 423: "The Slieve Gallion District," where he particularly comments on the remarkable absence of volcanic fragments in the upper and greater part of the mass, which, as already stated in my own essays, graduates downwards into a rock with felsitic matrix and ultimately into the underlying igneous rock.[1]

[1] "The most remarkable features of this agglomerate, which has been well described by Mr. Nolan, are the notable absence of truly volcanic stones in it, and the derivation of its materials from the rocks around it. I found only one piece of amygdaloid, but not a single lump of slag, no bombs, no broken fragments of lava crusts, and no fine volcanic dust or enclosed lapilli. The rock may be said to consist entirely of fragments of Silurian grits and shales where it lies among these strata, and of granite where it comes through that rock. Blocks of these materials, of all sizes up to two feet in breadth, are confusedly piled together in a matrix made of comminuted débris of the same ingredients. . . . . The essentially non-volcanic material of the agglomerate shows, as Mr. Nolan pointed out, that it was produced by æriform explosions, which blew out the Silurian strata and granite in fragments and dust. These discharges probably took place either from a series of vents placed along a line of fissure running in a north-westerly line, or directly from the open

From the inseparable association with the igneous core there can be no doubt that this peculiar agglomerate or breccia is due to æriform explosions by which the pre-existing crust was broken up while the volcanic energy ceased without any appearance of the uprising lava.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science. Seventy-first Annual Meeting, held at Glasgow, Sept. 11–18, 1901.

List of Papers read in Section C (Geology).

John Horne, F.R.S., President.

President's Address. (See p. 452.)

W. Gunn.—Recent Discoveries in Arran Geology.

G. Barrow.—On Variations in a certain Zone of the Eastern Highland Schists.

P. Macnair.—On the Crystalline Schists of the Southern Highlands, their Physical Structure, and its probable manner of Development.

Professor J. Geikie, F.R.S., and Dr. J. S. Flett.—The Granite of Tulloch Burn, Ayrshire.

Dr. J. S. Flett.—On Crystals Dredged from the Clyde near Helensburgh, with analyses by Dr. W. Pollard.

H. B. Woodward, F.R.S.—Note on a Phosphatic Layer at the Base of the Inferior Oolite in Skye. (See p. 519.)

——— Further Note on the Westleton Beds.

Professor W. W. Watts.—Report of the Committee for the Collection and Preservation of Geological Photographs.

Sir A. Gekie, D.C.L., F.R.S.—Time-intervals in the Volcanic History of the Inner Hebrides.

A. Harker.—The Sequence of the Tertiary Igneous Rocks in Skye. (See p. 506.)

A. M'Henry and J. R. Kilroe.—On the Relation of the Old Red Sandstone of N.W. Ireland to the adjacent Metamorphic Rocks, and on its similarity to the Torridon Rocks of Sutherland.

J. R. Kilroe and A. M'Henry.—On the Relation of the Silurian and Ordovician Rocks of the North-West of Ireland to the great Metamorphic Series.

G. H. Kinahan.—Notes on the Irish Primary Rocks with their associated Granitic and Metamorphic Rocks.

——— Some Laccolites in the Irish Hills.

Dr. R. H. Traquair, F.R.S.—The Geological Distribution of Fishes in the Carboniferous Rocks of Scotland.

——— On the Geological Distribution of Fishes in the Old Red Sandstone of Scotland.

fissure itself. Possibly both of these channels of escape were in use, detached vents appearing at the east end, and a more continuous discharge from the fissure further west. After the earliest explosions had thrown out a large amount of granitic and Silurian detritus, andesitic lava rose in the fissure, and, solidifying there, enclosed a great deal of the loose fragmentary material that fell back into the chasm." ("Ancient Volcanoes of Great Britain," vol. ii, p. 423.)

Miss C. A. Raisin, D.Sc.—Perim Island, and its Relation to the Area of the Red Sea.

R. L. Jack, LL.D.—The Artesian Water Supply in Queensland.

B. N. Peach, F.R.S.—The Cambrian Fossils of the N.W. Highlands.

Professor W. J. Sollas, F.R.S.—On a New Method in the Investigation of Fossil Remains. With illustrations, *Monograptus, Ophiura, Palæospondylus.*

R. Kidston, F.R.S.E.—Notes on some Fossil Plants from Berwickshire.

Dr. Wheelton Hind.—Report of the Committee for studying Life-zones in the British Carboniferous Rocks.

J. R. Kilroe.—Geology regarded in its Economic Applications to Agriculture by means of Soil Maps.

A. M. Bell.—Plants and Coleoptera of Pleistocene Age from Wolvercote, Oxfordshire.

Vaughan Cornish, D.Sc.—Report of the Committee on Terrestrial Surface Waves and Wave-like Surfaces.

Dr. R. F. Scharff.—Report of the Committee to Explore Irish Caves.

Professor P. F. Kendall and H. B. Muff.—Evidences of Ancient Glacier-dammed Lakes in the Cheviots. (See p. 513.)

Professor P. F. Kendall.—Report of the Committee on the Distribution of Erratic Blocks.

A. Smith Woodward, LL.D., F.R.S.—Report of the Committee for considering the best methods for the Registration of all Type Specimens of Fossils in the British Isles.

W. Barlow.—Report of the Committee upon the present state of our knowledge of the Structure of Crystals.

J. G. Goodchild.—On the Scottish Ores of Copper in their Geological relations.

——— A revised list of the Minerals known to occur in Scotland.

W. Mackie, M.D.—The occurrence of Barium Sulphate and Calcium Fluoride as cementing substances in the Elgin Trias.

——— On the Pebble Band of the Elgin Trias and the Wind-worn Pebbles.

——— On the occurrence of Covellite in association with Malachite in the Sandstone of Kingsteps, Nairn.

J. M. Maclaren.—On the Source of the Alluvial Gold of the Kildonan Field, Sutherlandshire.

——— Field Notes on the influence of Organic Matter on the deposit of Gold in Veins.

W. H. Wheeler.—On the Sources of the Warp in the Humber.

G. Barrow.—On the Alterations of the Lias Shale by the Whin Dyke of Great Ayton in Yorkshire.

E. H. Cunningham Craig.—On Cairngorms.

W. Ackroyd.—On the Circulation of Salt, and its Geological Bearings.

J. Rhodes.—Notes on the occurrence of Phosphatic Nodules and Phosphate-bearing Rocks in the Upper Carboniferous Limestone (Yoredale) Series of the West Riding of Yorkshire and the Westmoreland border.

——— Note on a Silicified Plant Seam beneath the Millstone Grit of Swarth Fell, West Riding of Yorkshire. (See p. 520.)

A. Smith Woodward, LL.D., F.R.S.—On the Bone-beds of Pikermi, Attica, and on similar Deposits in Northern Eubœa. (See p. 481.)

H. J. L. Beadnell.—The Fayum Depression. A preliminary notice of the Geology of a district in Egypt containing a new Palæogene Vertebrate Fauna.

Captain A. R. Dwerryhouse.—Report of the Committee on the Movements of Underground Waters of N.W. Yorkshire.

Professor E. Hull, F.R.S.—Notes on the Physical History of the Norwegian Fjords.

H. W. Monckton.—On the Origin of the Gravel-Flats of Surrey and Berkshire. (See p. 510.)

A. Somervail.—On the Occurrence of Diorite associated with Granite at Assouan, Upper Egypt.

James Stirling.—On some Hornblende Porphyrites of Victoria.

Malcolm Laurie.—Note on some Arthropods from the Upper Silurian.

F. P. Mennell.—The Copper-bearing Rocks of S. Australia. (p. 520.)

H. Bolton.—Report of the Committee on the Excavation of the Ossiferous Caves at Uphill, near Weston-super-Mare.

Section A (Mathematical and Physical Science).

Report of the Committee on Underground Temperature.

Report of the Seismological Committee.

F. N. Denison.—The Seismograph as a Sensitive Barometer.

Professor J. Milne, F.R.S.—On Meteorological Phenomena in relation to Changes in the Vertical.

Section B (Chemistry).

W. Ackroyd.—Inverse Relation of Chlorine to Rainfall.

——— The Distribution of Chlorine in Yorkshire.

Professor A. Michael.—On the Genesis of Matter.

Dr. E. F. Armstrong.—The Equilibrium Law as applied to Salt Separation and to the formation of Oceanic Salt Deposits.

Section D (Zoology).

Coral Reefs of the Indian Region. (Report.)

J. Stanley Gardiner.—The Coral Islands of the Maldives.

Dr. Francisco P. Moreno.—Exhibition of Photographs of Fossils in the La Plata Museum.

Section E (Geography).

Vaughan Cornish, D.Sc.—Report of Committee on Terrestrial Surface Waves.

H. N. Dickson.—The Mean Temperature of the Atmosphere and the Causes of Glacial Periods.

Dr. R. Bell, F.R.S.—The Topography and Physical Features of Northern Ontario.

R. T. Günther.—Report of the Committee on Changes of the Land-level of the Phlegræan Fields.

Section F (Economic Science and Statistics).

R. W. Dron.—Some Notes on the Output of Coal from the Scottish Coalfields.

SECTION G (ENGINEERING).

P. Bunau Varilla.—The Panama Canal.

J. Dillon.—Recording Soundings by Photography.

Vaughan Cornish.—Size of Waves observed at Sea.

SECTION H (ANTHROPOLOGY).

Miss Nina Layard.—Note on a Human Skull found in peat, in the bed of the River Orwell, Ipswich.

W. Allen Sturge, M.D.—On the Chronology of the Stone Age of Man, with especial reference to his coexistence with an Ice Age.

G. Coffey.—Naturally Chipped Flints for comparison with certain forms of alleged artificial chipping.

Ebenezer Duncan, M.D., and T. H. Bryce, M.A., M.D.—Remains of Prehistoric Man in the Island of Arran.

Miss Nina Layard.—An Early Palæolithic Flint Hatchet with alleged Thong-marks.

F. D. Longe.—A piece of Yew from the Forest Bed on the East Coast of England, alleged to have been cut by man.

G. Coffey.—Exhibit of Manufactured Objects from Irish Caves.

SECTION K (BOTANY).

Dr. H. Conwentz.—The Past History of the Yew in Great Britain and Ireland.

W. N. Niven—On the Distribution of certain Forest Trees in Scotland, as shown by the investigation of Post-Glacial deposits.

A. C. Seward, F.R.S., and Sybille O. Ford.—The Anatomy of *Todea*, with notes on the Geological History of the Osmundaceæ.

E. N. Arber.—On the Clarke Collection of Fossil Plants from New South Wales.

Professor H. Potonié.—Die Silur- und Culm-Flora des Harzes.

A. C. Seward, F.R.S.—A Chapter of Plant-evolution: Jurassic Floras.

——— The Structure and Origin of Jet.

II.—NOTE ON A PHOSPHATIC LAYER AT THE BASE OF THE INFERIOR OOLITE IN SKYE.

By HORACE B. WOODWARD, F.R.S., of the Geological Survey.[1]

AT the southern end of the great cliffs of Ben Tianavaig, south of Portree, in Skye, the basement beds of the Inferior Oolite, which contain large dogger-like masses of calcareous sandstone, rest in a hollow of the Upper Lias Shales, owing to local and to a certain extent contemporaneous erosion. Lining this hollow there is an irregular and nodular band, two or three inches thick, of dark brown oolitic and phosphatic rock; a fact of interest, as instances of local erosion are often attended by the accumulation of phosphatic matter in beds, nodules, and derived fossils.

Mr. George Barrow, who made a rough analysis of the rock, estimated the amount of phosphate of lime at about 50 per cent.; and Mr. Teall, who examined a section under the microscope, noted,

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901, and communicated by permission of the Director of the Geological Survey.

in addition to the oolite grains, fragments of molluscan shells and echinoderms, and foraminifera, in a finely granular matrix formed of calcite. He observed that the central portions of some of the oolite grains were formed of a nearly isotropic brown substance in which the typical concentric structure of the oolite grains was well preserved. This substance was no doubt phosphatic.

III.—Note on the Discovery of a Silicified Plant Seam beneath the Millstone Grit of Swarth Fell, West Riding of Yorkshire. By John Rhodes, of the Geological Survey.[1]

BY kind permission of the British Association Committee on Carboniferous Zones I am enabled to record the discovery of a silicified plant seam beneath the Millstone Grit at Swarth Fell, and two miles north-west of Hawes Junction.

The exact geological position of the overlying strata is doubtful, but apparently they occupy the horizon of the grindstone or ganister of the district.

At this particular place, however, the grindstone or ganister is absent, and its place is taken by flaggy silicious limestones with marine shells and by a bed of highly silicious grit with plant remains, the latter resting more or less directly on the silicified plant seam.

Chert occurs, probably as lenticles in the uneven surface of the seam, and contains a mass of detached silicious sponge spicules, apparently rod-like bodies, which may belong to the anchoring ropes of hexactinellid sponges. In the same chert are included fragments of silicified plant remains beautifully preserved.

In the plant seam included pebbles of silicious grit occur, which contain a few spicules similar to those in the chert, and also plant remains. The plant seam rests on a layer of silicified shale containing a few fragmentary sponge spicules, mostly rod-like forms, one piece belonging to an hexactinellid sponge. The beds below are more or less rotted clay shales with ironstone nodules.

I am indebted to Dr. G. J. Hinde for notes on the sponge remains directly associated with the plant seam. The plants have not been determined, but have been placed in the hands of R. Kidston, Esq., F.R.S.E., F.G.S., Stirling.

IV.—The Copper-bearing Rocks of South Australia. By F. P. Mennell.[1]

THE author drew attention to the fact that the copper ores of Yorke's Peninsula in South Australia were the first metallic minerals worked on the Australian continent. They occurred in rocks of Archæan age, which at Moonta and Wallaroo had been subjected to crushing and shearing to such an extent that they presented but few traces of their original structures, except in the case of a diorite at Wallaroo, which was of a typically plutonic character. Most of the rocks were mylonites, and in some instances

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

they had been reduced to a compact flinty type in which none of the minerals could be recognized with certainty. Where the original constituents had survived they were of a fragmentary character. Oligoclase seemed to have best resisted the crushing, and orthoclase occasionally remained in lenticles, but the brittle quartz had been invariably reduced to powder. Mr. Mennell thought that the economic aspect of the examination was of considerable importance, for the mines had been shut down several times when the ore had thinned out owing to doubts as to its permanence. From the character of the rocks it was, however, obvious that they occurred in a true 'fissure lode,' and no doubts need be felt as to the continuance of the ore to the limit of workable depths.

V.—The Geologic Distribution of *Pollicipes* and *Scalpellum*.[1]

By F. A. Bather, D.Sc., F.G.S.

IN a valuable memoir on the "Hudson River Beds near Albany, and their taxonomic equivalents," published as Bulletin of the New York State Museum, No. 42, April, 1901, Dr. Rudolph Ruedemann describes a number of variously shaped valves found in the Upper and Lower Utica Shale of Green Island and Mechanicsville, N.Y. (p. 578, pl. ii). These he believes to "find their homologues in parts of the capitula of the pedunculate cirriped genera *Scalpellum* and *Pollicipes*, notably of the latter. On this account the various valves have been united under the caption *Pollicipes siluricus*, in full consciousness of the enormous gap existing between the appearance of this Lower Siluric type and the next Upper Triassic (Rhætic) representatives of these genera." Confirmation of Dr. Ruedemann's ascription may be derived from the fact that "the enormous gap" does not exist. Early in 1892 Dr. C. W. S. Aurivillius[2] published the descriptions of *Pollicipes signatus* from bed *e* (= Lower Ludlow), *P. validus* from bed *c* (= Wenlock Shale), *Scalpellum sulcatum*, *S. varium*, *S. granulatum*, *S. strobiloides*, *S. procerum*, *S. cylindricum*, and *S. fragile*, all from bed *c*, of the island of Gotland. The species of *Scalpellum* are founded on peduncles, *Pollicipes validus* is represented by a broken scutum only, but *P. signatus* is based on an almost perfect specimen. The occurrence of more than one species of both these genera in the Silurian lends significance to the diversity of form presented by Dr. Ruedemann's specimens. The ornament on his fig. 18 most nearly resembles that of *P. signatus*, while the rostrum, fig. 22, is also not unlike that species. Figs. 16, 17, and 19 may belong to more than one other species, while 24 (with which presumably 25 is to be associated) may belong to a *Scalpellum*, as Dr. Ruedemann seems to hint. In the circumstances it is specially regrettable that Dr. Ruedemann has selected no one of these specimens as the holotype of *Pollicipes siluricus*. If he does not do so soon, confusion is pretty certain to arise.

[1] Reprinted from *Science*, July 19th, 1901, p. 112 (N.S., vol. xiv, No. 342).

[2] Bihang Sveska Vet.-Akad. Handl., xviii, Afd. iv, No. 3.

Figs. 13, 14, and 15 are referred to *Turrilepas* (?) *filosus*, n.sp. A recent examination of the plates of that genus suggests to me that the note of interrogation is fully justified.

Aurivillius considered that *Pollicipes signatus* showed a closer approach to the Balanidæ than any other of the Lepadidæ, but he too, in ignorance of the Devonian *Protobalanus*, Whitf., discoursed needlessly about the gap in the distribution. Now that the range of the Lepadidæ has been extended to the Ordovician, we may look confidently for further discoveries. We may also hope that the time has now come when even the textbooks may awake to the fact that the genera *Pollicipes* and *Scalpellum* existed in Palæozoic times.

My apology for insisting on this is not merely that both Dr. Aurivillius and Professor Lindström, who supplied him with the material, have unhappily passed away, but that I had the good fortune to be the discoverer of the beautiful specimen of *Pollicipes signatus*, when developing a specimen of *Gissocrinus verrucosus* from the *Pterygotus* bed of Wisby Waterfall, in May, 1891. The very fragile specimen was subsequently licked into shape (no metaphor is intended) by Mr. G. Liljevall, to whom the excellent drawing of it is due.

VI.—The Caucasian Museum, Tiflis, is publishing a complete Catalogue of its Collections, in both the Russian and German languages, the title in the latter tongue being: "Die Sammlungen des Kaukasischen Museums im Vereine mit Special Gelehrten bearbeitet und herausgegeben von Dr. Gustav Radde, Direktor, etc." The catalogue is in the form of quarto volumes, in boards, measuring 31×23 cm. Volume III, which has been sent to us for review, deals with the geological collections, and is by Professor N. I. Lebedev. It consists of xii + 322 pp. and 8 plates. The material is arranged under the heads of the several collections, which are classified quite roughly, apparently following the localities in the order in which they were visited. Among the collections that of Abich from Daghestan is one of the most famous; this is accompanied by a descriptive catalogue which is in greater detail than the present one and will be published *in extenso* in *Mittheilungen des Kaukasischen Museums*. There are also donations by successive chiefs of the Office of Mines; the collections of F. Bayern, chiefly of value for the exactness of the localities given, and worked over by Arzruni, Valentin, and Lebedev; other collections that have afforded material for the writings of these geologists, of Simonovitsch, and others. The preceding are all local, but there are also collections serviceable for comparison, especially those from the Crimea, Bessarabia, and Transcaspian, as well as a fine series from various horizons and localities in Western Europe, partly purchased and partly the gift of Mr. J. de Morgan. The present catalogue does not profess to be much more than a rough list, and, as is only natural in a work produced under such disadvantageous conditions as regards literature and the help of specialists, the determinations are clearly lacking

in precision. The work will nevertheless be useful to two classes of students; those who are investigating the geology and physical history of the Caucasus, and specialists in petrology or palæontology who desire to see all the material available for their researches. In his readiness to enter into relations with specialists Dr. Radde pursues an enlightened and liberal policy, so that readers of the catalogue need not imagine that because the specimens are in Tiflis it is no use to trouble about them. The collotype plates illustrating this volume afford a sample of the treasures within; two are of rock-sections, one of undescribed species of Ammonites, and two of species of *Cardium, Congeria, Dreissenia, Rissoa, Neritina,* and *Natica*; one of the figures is labelled "*Cardium apscheronicum*, n.sp.," but we can find no description.

VII.—Geology of Devonshire.—The main part of No. 3 of the Proceedings of the Geologists' Association of London is devoted to an account of the excursion made by the members to the Start, Prawle, and Bolt districts during Easter this year. The report is written by W. A. E. Ussher, who gives in his introductory remarks, as well as in his report, a good deal of interesting matter which will be much appreciated by Devonians especially. In the report are incorporated many notes by A. R. Hunt. The result enabled those who enjoyed the excursion to realize the geological difficulties of the region, and served to whet their appetites for the long-expected memoir upon it.

VIII.—On a New Fossil Lizard from the Beds of the Lower Chalk Formation in the Island of Lesina [Coast of Dalmatia]; by A. Kornhuber.—"Ueber eine neue Fossile Eidechse aus den Schichten der unteren Kreideformation auf der Insel Lesina." (Verhandlungen der k.k. geol. Reichsanstalt, 1901.)—In this paper the author describes another of the remarkable reptilian skeletons from the thinly bedded Lower Cretaceous limestones of the island of Lesina. In this instance the skeleton is that of a lizard about 1·4 metres long, apparently in its general structure related to the Varanidæ, but in its dentition approaching the Mosasauridæ. The specimen is made the type of a new genus, *Opetiosaurus*, the specific name being *O. Bucchichi*.

IX.—Shorter Notices.—Georgia Bauxite.—The most important article in the *American Geologist* for July is T. L. Watson's account of the Bauxite deposits of the Coosa Valley region of Georgia and Alabama. Discovered in 1887, these fields now provide the entire home consumption of the United States. After a sketch of the geology of the area and the geological position of the mineral, the author deals with the associated minerals, chemical composition, origin, and age of the deposits. This latter is apparently the close of the Eocene period.

Beach Structure.—Another article in the same Journal of considerable interest is H. L. Fairchild's "Beach Structure in Medina Sandstone," which is illustrated by five plates of reproductions from photographs. The author describes the various

appearances due to abrupt change of material, oblique bedding, ripples, wave-lines, ridges, and troughs, and has come to the conclusion that this 1,075 feet of arenaceous shale is a typical sandy beach deposit.

Chili and Argentina.—The long dispute over the boundary-line between these two countries is further illustrated by Charles Rabot in La Géographie, No. 4, 1901. As the frontier line involves the watershed, the arbitration at present proceeding is of vital importance to both countries. Rabot gives some excellent reproductions from photographic views of the glacial phenomena of the district, and a particularly clear map showing the differences between the claims of the two countries.

Professor C. E. Beecher gives an account in the Yale Scientific Monthly for June, 1901, of the mounting of the complete skeleton of the dinosaur *Claosaurus annectens*. This is the first complete skeleton of a dinosaur yet set up, and came from the Laramie beds. It belonged to the Marsh Collection, is 29 feet in length, and is placed in the Yale University Museum. A plate accompanies the notice.

"Maryland and its Natural Resources" is the title of a pamphlet which has been prepared by W. Bullock Clarke as the official publication of the Maryland Commissioners at the Pan-American Exposition.

Indian Tertiary Belemnites.—The announcement is made in the Report of the work carried on by the Geological Survey of India, 1900–1901, that Dr. F. Noetling has found great numbers of true Belemnites in Lower Eocene beds near Jhirrak, in Sind.

The Typhoon, Luzon.—The typhoon which swept Luzon on the 8th September, 1900, forms the subject of a memoir by Padre José Coronas, S.J., which was issued by the Observatorio di Manila, 1900. Beyond generalities, however, it has little geological interest.

Woodwardian Museum, Cambridge.—The additions made last year comprised, among other things, the collections of the late C. J. A. Meÿer, the greater part of a skeleton of *Lutra vulgaris* from the peat of Barwell, and part of the S. S. Buckman Collection of Inferior Oolite Ammonites. Mr. Reed has been at work on the British and Foreign Palæozoic fossils, Mr. Woods on the Cretaceous fossils, and Mr. Asher on the fossil plants. The identification of figured specimens continues to make satisfactory progress, and we hope a revised catalogue of types will soon be attempted.

Professor J. M. Clarke, State Palæontologist of New York, announces in the 54th Annual Report of the New York State Museum that a catalogue of the type fossils used throughout the history of the "Palæontology of New York" is in hand. Specimens of type fossils, as they are identified and can be replaced by duplicates, are removed to a fireproof building, in accordance with the vote of the Regents in 1882. It would be a good plan to have casts made of them, for inclusion in the general collection.

Messrs. C. Davies Sherborn and B. B. Woodward are issuing a series of papers on the dates of publication of various French Voyages which appeared between 1800 and 1900. The papers will be found in the Annals and Mag. Nat. Hist. for April, August, and October, and contain many notes on geological papers which have heretofore presented difficulties as to date.

New Foraminifera.—R. J. Schubert has a paper on some Foraminifera from the Upper Chalk of East Galicia, in the Jahrb. k.k. geol. Reichs., L (4), 1901. The chief novelty is a curious form to which he gives the name of *Karreria cretacea*. J. Grzybowski writes on the Foraminifera of the *Inoceramus* beds of Gorlice. His paper appears in the Bull. Internat. Ac. Sci. Cracovie for April, 1901. Two plates, chiefly devoted to arenaceous forms, are given.

From the Report of Progress of the Manchester Museum we gather that the Geological Department has been enriched by the Barnes Collection of Carboniferous invertebrates, and some selections from the Jukes-Browne Collection. Fossil plants have received a good deal of attention, the types and figured specimens of Oolitic species, which were examined by Mr. Seward, having been labelled and displayed. Mr. R. D. Darbishire has presented the Museum with a specimen of the recent *Pleurotomaria adansoniana* from Barbados, an important and valuable acquisition to any collection.

New Jersey Geology.—The annual report of the State Geologist of the Geological Survey of New Jersey for 1900 contains an administrative report; Report on the Palæozoic Formations, by Stuart Weller, consisting of Hardiston Quartzite, Kittatinny and Trenton Limestones, and Hudson River Beds; Report on the Portland Cement Industry, by H. B. Kümmel; Artesian Wells in New Jersey, by Lewis Woolman; Mineralogical Notes, by A. C. Chester; Chlorine in the Natural Waters of the State, by W. S. Myers; and the Mining Industry, by H. B. Kümmel.

Portuguese Geology.—Paul Choffat has published in the Bull. Soc. Belge Geol., xv, May, 1901, an important paper on the "Limite entre le Jurassique et le Crétacique en Portugal." From a careful study of the different exposures and the fossils contained in the beds, he comes to the conclusion that the limit between the two systems in Portugal must be regarded as only a conventional one. He finds that both the fauna and flora show an almost imperceptible passage between the two formations in certain places.

CORRESPONDENCE.

FOSSILS AND GARNETS.

Sir,—If your correspondent "Verbum Sap." had signed his own name I would have endeavoured to explain to him my reasons for writing the paragraph which he quotes, though I knew that the "traditions of the elders" might be cited against me by dealers

in second-hand science. As it is, I content myself with remarking that the maxim "Verbum sat sapienti" has only a very limited application in scientific matters, for there a diet of words is both innutritious and flatulent. But as he evidently loves "wise saws" I will add another to his store, "Words are the counters of wise men and the money of fools."

T. G. Bonney.

INTRUSIVE IGNEOUS ROCKS IN IRELAND.

Sir,—With reference to the interesting paper on "Intrusive, Tuff-like, Igneous Rocks and Breccias in Ireland," by Messrs. Kilroe and M'Henry, published in the August number of the Q.J.G.S., it is noteworthy that there are in the neighbourhood of Snowdon several instances of intrusive rocks of so fragmentary and brecciated a character as to resemble volcanic agglomerates. Such is the case in part with the diabase occurring in Cwm Llan, S.S.E. from the summit of Snowdon. Other instances of this character that I have observed are a small boss of brecciated diabase at the base of the felstone of Cribiau, near Bwlch Ehediad, and another, also of a fragmentary character, amidst the felsitic rocks on the south-east side of Llyn Gwynant. Somewhat similar too is the greenstone on Glyder Fawr, which Ramsay in his memoir on North Wales describes as a "great vesicular, rubbly-looking patch."

J. R. Dakyns.

Snowdon View, Nant Gwynant, Beddgelert.
October 10, 1901.

EBBING AND FLOWING WELLS AND SPRINGS.

Sir,—Some time back you were good enough to print a communication from me on the ebbing and flowing well between Buxton and Castleton in Derbyshire. In the *Illustrazione Popolare* of August 18th of this year is a paper on a phenomenon of the Lago di Garda of kindred character, of which I submit a substantial translation.

"The Lago di Garda is one of the largest lakes in Italy, admired for the fertility of the country that surrounds and for the beauty of the gardens that adorn its shores. There happens in these days a phenomenon that impresses the surrounding population; a flux of thirty centimetres of height every forty minutes is observed, according to the boatmen. Many newspaper readers wish to explain it as a result of volcanic action.

"The phenomenon may have a volcanic origin, since from the beginning of 1800 Count Bettoni, a studious naturalist, had to verify in the lake a species of flux and reflux, not perilous but irregular and inconstant; and not only is it in the Lago di Garda observed, but in the lake of Geneva the water rises and falls in a notable manner.

"The phenomenon cannot be attributed to the action of the sun and moon, since the action of these two stars should produce a rise and fall regularly as in the level of the sea.

"Some scientists were of opinion that the rise and fall were the result of wind action, but how can the rise and fall be explained when there is sometimes not a breath of wind? Others were of opinion that the rise and fall might be due to unexpected melting of the snow, and to the action of electric clouds, but if so, why not a like action on all other Italian lakes?

"The most probable cause of such uprising, according to the hypothesis of the Engineer Pedrini, is found in the gases which, arising from the bed of the lake and seeking a vent pass across the water, produce undulations, and sudden upward movements of like nature to those observed in the lake of Geneva by Lembari. In the Lago di Garda emanate continuously an infinity of gas bubbles, and thermal springs are observed.

"The action of the sun upon the Mediterranean raises the water only eighteen inches, and if this attraction on so large a surface is thus weak, the surface of the Lago di Garda is too small comparatively to be at all affected.

"In the bay of Peschiera, about a hundred steps from Sermione, there are at three different points springs with an unpleasant odour, manifesting the existence of sulphuretted hydrogen gas. Incrustations from thermal waters are to be seen on the eastern side of the lake, about one mile distant from the grotto of Catullus.

"The fishermen take particular care to extend their nets a distance from these springs; if they happen to draw the nets over them, they rot in a short time."

T. E. Knightley.

106, Cannon Street, E.C.
September 9, 1901.

OBITUARY.

EDWARD WALLER CLAYPOLE.

Born June 1, 1835. Died August 17, 1901.

Professor E. W. Claypole, one of the many noted geologists of the United States, was of English extraction, having been born at Ross, Hereford, on 1st June, 1835. He was educated privately and graduated at the London University, taking his B.A. in 1862 and becoming D.Sc. in 1888. In 1871 he emigrated to the United States, and in 1873 became Professor of Natural Science at Antioch College, Ohio, a post which he held until 1881. He was Palæontologist to the "Second Geological Survey of Pennsylvania" and Professor of Natural Science at Buchtel College, Akron, Ohio, from 1883 to 1898, when he succeeded Professor A. J. McClatchie as Instructor of Biology (to which Geology was afterwards added) at the Throop Institute, Pasadena, California. This office he retained until his sudden death from apoplexy at Long Beach, California, 17th August, 1901. He was a genial and successful teacher, much beloved of his pupils, while his varied attainments find reflection in the scope of his numerous scientific papers, although geology holds the principal place.